நூலகம்
வனத்துறைத் தலைவர் அலுவலகம்
சென்னை-600 006

THE INDIAN FORESTER

வனத்துறைத் தலைவர் அலுவலகம்
நூலகம்
18 ஆக 1988
சென்னை-600 006

Founded in 1875

Volume 114 JUNE 1988 No. 6

Telegram Indian Forester

Telephone : 27021/264

INDIAN FORESTER

(A Monthly Journal of Forestry and Forestry Research)

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VOLUME 114 NUMBER 6

THE
INDIAN FORESTER
JUNE, 1988

THE STOMATA OF *EUCALYPTUS* HYBRID TREES FROM A TRANSECT ACROSS THE TARAI AREA OF UTTAR PRADESH, INDIA

S. NAUTIYAL* AND E.R.C. REYNOLD**

Introduction

Stomatal openings are the essential gateways through which much of the water vapour and gaseous exchange, involved in transpiration, photosynthesis and respiration takes place (Nutman, 1937; Hygen, 1951; 1953; Stalfelt, 1955; Willis and Jefferies, 1963; Waggoner and Zelitch, 1965). In recent years there has been considerable interest on the ecological and agronomic implications of stomatal control for water economy and net productivity and this has resulted in substantial enrichment of the knowledge of structure, function and ecology of stomata (Shimshi, 1963 a, b; Meidner, 1965; Zelitch, 1967; Waggoner and Pallas, 1968).

Today there are many schools of thoughts regarding the water use efficiency of *Eucalyptus* (Vandana and Bandyopadhyay, 1985; Rawat *et al.*, 1984; Dabral, 1970; Karschon and Heth, 1967) and many of them alleged that *Eucalyptus* hybrid has very high rate of transpiration and ultimately has adverse effect on ground water table. Keeping this view in mind a study was undertaken to determine under what conditions the *Eucalyptus* hybrid, so widely planted in India can tap the water table by deep roots.

Materials and Methods

To compass a wide range of water table depths in a Tarai area near Haldwani, Uttar Pradesh (Reynold *et al.*, 1987 unpublished), ten dominant trees were chosen at regular intervals along the transect, number 1 in the North and number 10 in the South (Figs. 1 & 2). In the event, only tree No. 1 had a distinctively deep water table, the rest were in the range 1.4 to 2.5 m deep with probably rather little seasonal fluctuations. Tree No. 1, 4, 7 and 10 were felled in the period 20-28 June, 1986 and 2, 3, 5, 6, 8, 9 in 22-30 October, respectively. Immediately after felling tree towards North, sample leaves were removed and their surfaces painted with collodion solution. After the collodion layer had

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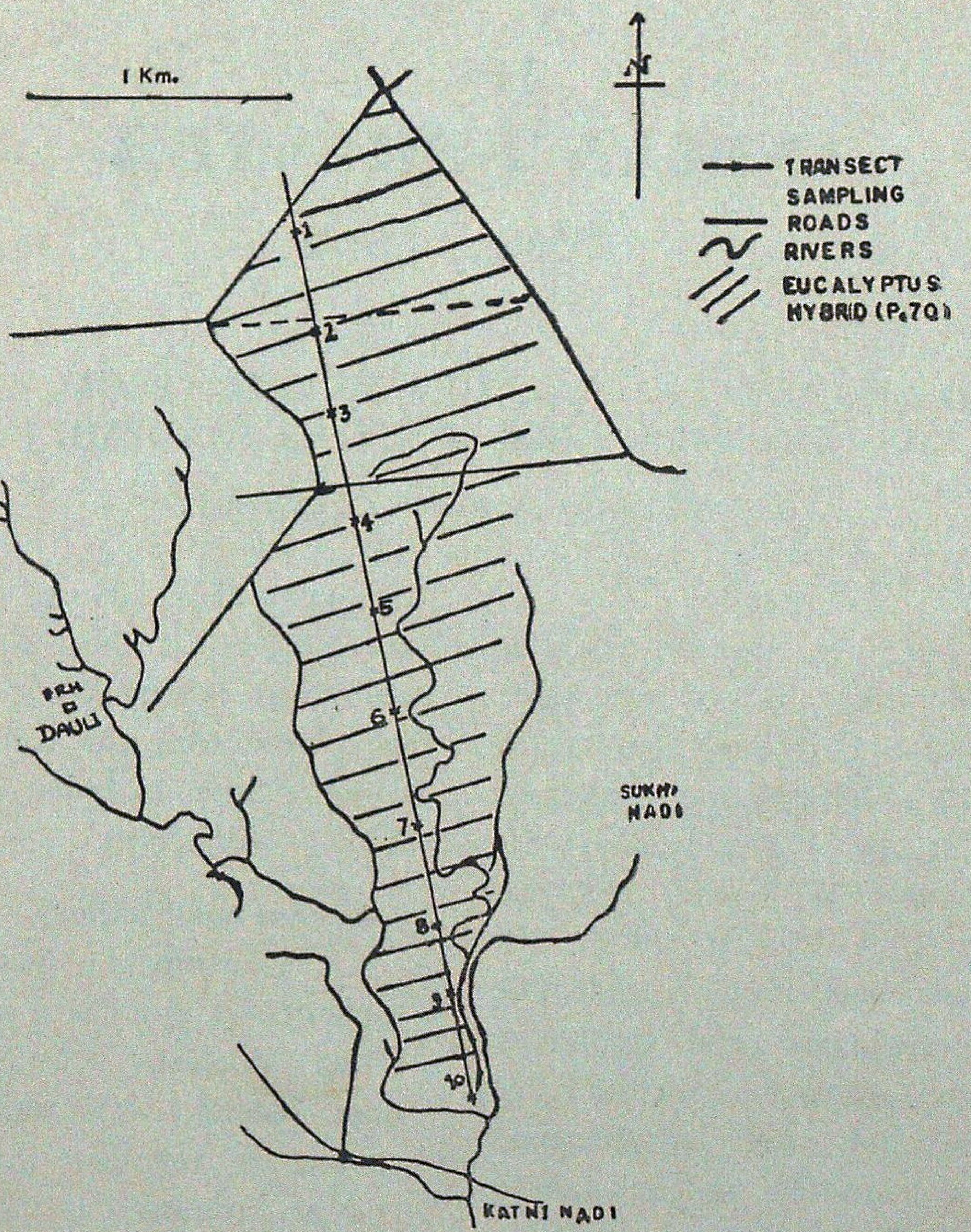
Fig. 1

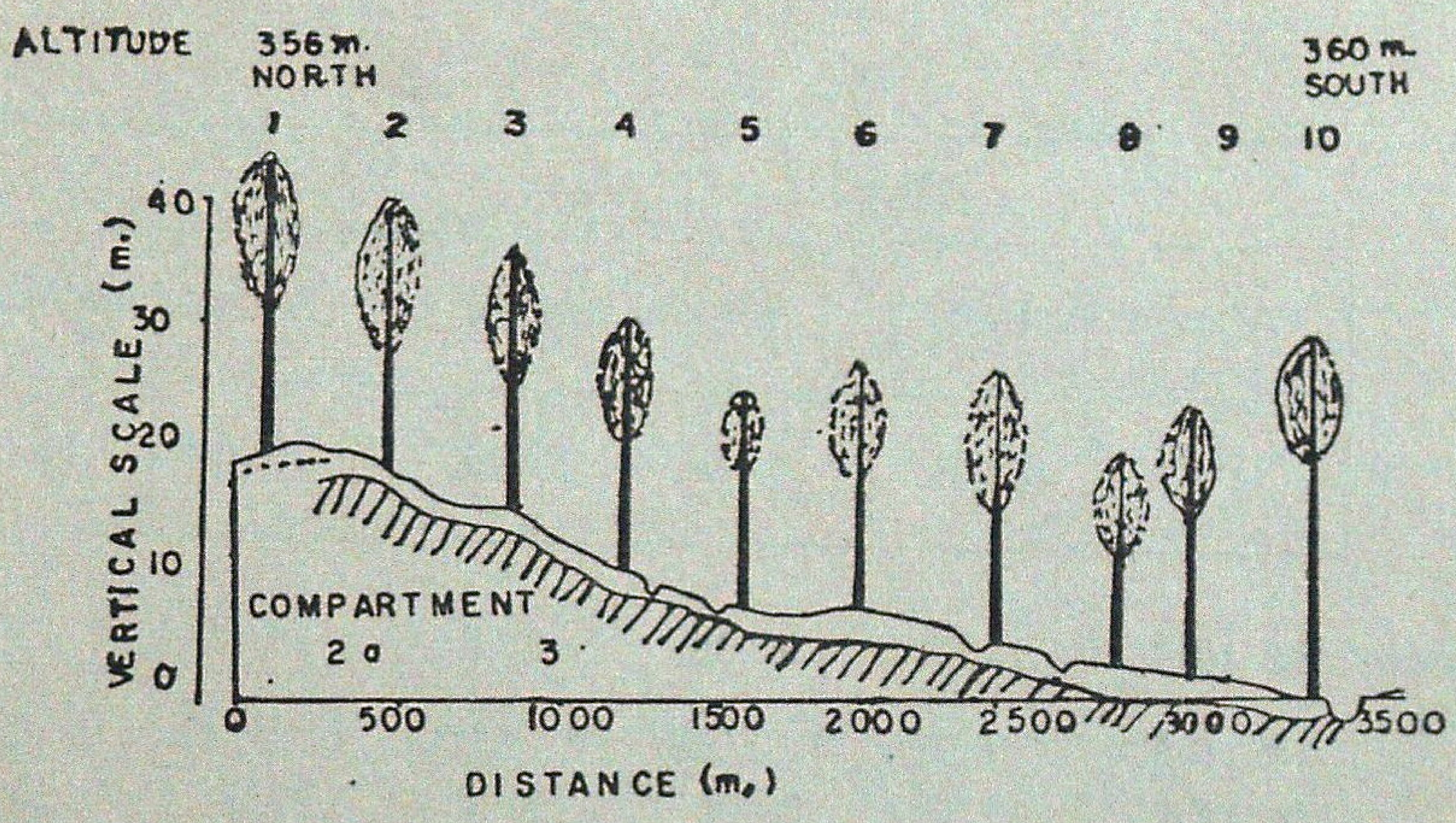


Approximate transect in Horai Block, Kishanpur Range, Tarai East, U.P.

dried, it was stripped off and examined under high power microscope in the laboratory.

On the first occasion young and mature leaves from the Eastern aspect of mid crown were examined on both proximal and distal ends and both adaxial and abaxial surfaces, whereas on the second occasion, the mature leaves from each of three aspects (East, West and North) were taken for study under microscope. 10 microscopic fields were examined and 100 stomata were observed for each of the measurements. The observations recorded comprised of (i) the number of stomata per unit area (0.113 mm^2), (ii) the number of open stomata, (iii) the length and (iv) width of stomata with and without guard cells.

Fig. 2



Sketch of approximate profile of transect (160° from North) Horai, Kishanpur Range, Tarai East, U.P., P. 70 (Coppiced 1978) hybrid *Eucalyptus.*

A transect of 3.5 km in length at 160° from North was laid out in silviculturally uniform hybrid *Eucalyptus* stand.

The area of study falls under 79°17′E; 29°4′ N more or less between parallel streams and nalas run from North to South. The North end of the transect was at 356 m and South end at 336 m above m.s.l. The drainage pattern produced along the numerous minor undulations.

The air temperature varied from 22°C to 37°C during (20-28 June, 1986) and 13°C to 30°C during 22 to 30 October, 1986.

Results and Discussion

Water relation and stomatal behaviour are important indices which reflect the ability of plants to economise essential requirements under prevailing climatic and edaphic conditions.

The data of pre-monsoon is presented in Table 1 and the statistical analysis in Table 2. No proper trend was observed in the size of stomata with regard to tree number but only the width of stomata of tree No. 1 (where the water table is deeper) is less as compared to the tree No. 10 (where water table is shallow) on abaxial surface indicating that the availability of ground water to the tree No. 10 was more for full evapotranspiration as it is studied near the meeting point of two perennial streams. Rawat *et al*. (1984) also concluded that *Eucalyptus* has the capacity to transpire water abundantly under conditions of adequate soil moisture which they termed as "Luxury consumption" but they also reported that under conditions of moisture stress, the water conserving mechanisms are triggered as may be the case of tree No. 1 in present study.

Table

Stomatal distribution and size (*Eucalyptus hybrid*)

(Means with

		Tree-1				Tree-4		
		Abaxial surface		Adaxial surface		Abaxial surface		Adaxial
		Top	Basal	Top	Basal	Top	Basal	Top
No. of stomata per unit area * SE	M	19.8	22.80	22.36	24.8	19.11	15.7	19.27
		* 0.879	* 0.736	* 0.729	* 9.28	* 1.111	* 0.817	* 0.799
	Y	18.4	17.27	20.01	21.3	29.09	20.6	15.73
		* 0.718	* 0.557	* 0.725	* 0.825	* 0.625	* 0.702	* 0.764
No. of stomata open * SE	M	16.9	19.36	17.18	19.9	14.33	11.2	15.09
		* 0.912	* 0.388	* 0.538	* 0.650	* 0.866	* 0.680	* 0.909
	Y	15.2	15.09	16.00	18.45	22.09	15.2	22.36
		* 0.573	* 0.579	* 0.632	* 0.539	* 0.814	* 0.651	* 0.650
Ratio/open Total No.	M	0.853	0.848	0.765	0.802	0.749	0.713	0.783
	Y	0.823	0.873	0.785	0.886	0.759	0.762	0.784
Lengtn of stomata * SE	M	9.7	8.91	7.27	8.1	9.55	10.5	10.64
		* 0.746	* 0.847	* 0.634	* 0.690	* 0.58	* 0.619	* 0.527
	Y	10.6	10.36	9.0	8.80	7.82	10.20	9.09
		* 0.786	* 0.527	* 0.820	* 0.568	* 0.672	* 8.554	* 0.368
Width of stomata with guard cells * SE	M	8.3	7.45	6.273	7.20	8.33	8.80	8.82
		* 0.857	* 0.802	* 0.60	* 0.772	* 0.471	* 0.442	* 0.400
	Y	8.6	8.64	8.0	6.92	6.09	8.2	7.27
		* 0.670	* 0.491	* 0 730	* 0.483	* 0.595	* 0.646	* 0.469

M = Mature leaf Y = Young leaf

* denotes ±

Note : Figure given in length and width of stomata are the parts (number) of the ocular

1

on leaves from eastern aspect of 4 trees June, 1986.
standard error)

	Tree-7				Tree-10			
surface	Abaxial surface		Adaxial surface		Abaxial surface		Adaxial surface	
Basal	Top	Basal	Top	Basal	Top	Basal	Top	Basal
21.82	18.27	20.73	17.58	20.42	28.0	24.2	19.7	18.90
* 0.996	* 1.036	* 0.905	* 0.733	* 1.011	* 1.125	* 0.912	* 0.578	* 0.563
16.64	21.5	19.8	17.18	16.91	26.5	23.6	19.545	18.7
* 0.664	* 1.147	* 1.073	* 0.861	* 0.530	* 1.014	* 1.424	* 0.857	* 0.904
17.82	14.19	17.91	15.08	17.00	20.8	20.3	14.9	15.0
* 0,422	* 0.653	* 0.624	* 0.608	* 0.878	* 0.904	* 1.116	* 0.737	* 0.588
12.54	13.9	14.0	12.36	12.36	20.4	19.1	16.0	12.0
* 0.608	* 0.924	* 0.615	* 0.664	* 0.801	* 1.035	* 1.149	* 0.674	* 0.843
0.817	0.816	0.863	0.857	0.832	0.749	0.838	0.756	0.794
0.753	0.646	0.707	0.861	0,730	0.769	0.869	0.820	0.641
10.18	9.36	10.27	10.17	9.67	9.1	9.1	8.1	7.909
* 0.615	* 0.509	* 0.675	* 1.079	* 0.555	* 0.605	* 0.605	* 0.623	* 0 680
9.09	7.6	9.6	8.54	8.64	8.2	8.8	10.18	8.7
* 0.495	* 0.702	* 0.542	* 0.511	* 0.56	* 0.611	* 0.680	* 0.40	* 0.488
8.82	7.73	8.64	8.58	7.92	6.5	6.5	5.5	5.454
* 0.536	* 0.449	* 0.544	* 0.860	* 0.570	* 0.563	* 0.563	* 0.619	* 0.528
7.54	6.4	7.7	7.09	6.91	5.5	6.4	9.273	7.5
* 0.629	* 0.670	* 0.633	* 0.610	* 0 610	* 0.477	* 0.6	* 0.428	* 0.563

micrometer. The value of one part is 0.0025 mm or 2.5 μm.

Table 2

Means of data from previous table with statistical tests of differences.

	Tree				Leaf surface		Position of Leaf		Leaf Age	
No. of stomata per unit area (A)	Tree No. 4 (22)	Tree No. 1 (21)	Tree No. 7 (19)	Tree No. 10 (19)	AB (21)	AD (21)	T (21)	B (20)	M (21)	Y (20)
	(N.S.)				(N.S.)		(N.S.)		(N.S.)	
No. of stomata open (B)	$\overline{T_4}$ (17)	$\overline{T_1}$ (17)	$\overline{T_7}$ (15)	$\overline{T_{10}}$ (14)	AB (17)	AD (15)	T (16)	B (16)	M (16)	Y (15)
	(*)				(*)		(N.S.)		(N.S.)	
Ratio (B/A)	T_1 (0.823)	T_4 (0.773)	T_{10} (0.770)	T_7 (0.766)	AB (0.789)	AD (0.778)	T (0.789)	B (0.778)	M (0.803)	Y (0.764)
	(N.S.)				(N.S.)		(N S.)		(N.S.)	
Length of stomata	T_7 (9.66)	T_{10} (9.0)	T_1 (8.95)	T_4 (8.46)	AB (9.18)	AD (8.86)	T (9.22)	B (8.22)	M (9.02)	Y (9.02)
	(N.S.)				(N.S.)		(N.S.)		(N.S.)	
Width of stomata	$\overline{T_7}$ (8.13)	$\overline{T_1}$ (7.58)	$\overline{T_{10}}$ (7.50)	T_4 (6.29)	AD (7.48)	AB (7.27)	B (7 44)	T (7.30)	Y (7.45)	M (7.29)
	(*)				(N.S.)		(N.S.)		(N.S.)	

* Indicates significance at 5% level.

Bar above means indicates differences are not significant at 5% level.

N.S. indicates non-significance at 5% level.

AB—Abaxial side T—Top position Y—Young leaf

AD—Adaxial side B—Basal position M—Mature leaf

Among the characters which are morphological rathar than transitory (Stomatal opening) only the width of stomata showed significant differences between trees (but not between leaf ages, surfaces or regions). This is in contrast to the significant differences between the number of stomata open; that is a tree which had narrower stomates also had a larger number of open stomata. But the width effect is in the same order as the non-significant variation in stomatal length (again distinguishing these dimensions from the effects of stomatal movements). Thus, the product of the two characters differs between the extremes by as much as 38%. However, we have no particular reason to think that the moisture supply of tree No. 2 differs materially from tree 7 and 10 though we suspect that for much of the year tree No. 1 would be under greater water stress. This indicates that stomatal characters developed under different moisture regimes are different.

To see the effect of direction on stomatal behaviour, the leaves from East, West and South positions were collected after post-monsoon visit and the results obtained are shown in Table 3 and 4. The studies were conducted only on the abaxial surface (basal portion) of the leaf. The maximum number of stomata per unit area (0.113 mm^2) were found in tree No. 2 and minimum in tree No. 6. In Eastern side the number of stomata as well as open stomata decreased from tree No. 2 to 9 while increasing trend was observed in South and West directions respectively.

An analysis of variance was carried out to see whether the trees and aspects exhibit any significant difference in their effects on each of the characters studies separately. It was found that for all the characters, the tree as well as the aspects did not differ in their effects significantly. However, the interaction of trees and aspects were found to be significant for all the characters studied.

Tentatively, we must conclude that the measured characters were subject to inheritance. Admittedly, we know insufficient of the phenology of the *Eucalyptus* growing in the Tarai area to say whether the young or the mature leaf samples were developing when some stress would be expected. In passing with the limited meteorological data available from nearby Pantnagar University, it seems that the opening of the stomata of tree No. 4 and 1 was related to lower air temperatures rather than moisture replacement.

Table

Stomatal distribution and size (*Eucalyptus hybrid*) *on the abaxial surface* (*Basal portion*)

(Means with

	East Trees Nos.								
Parameters	2	3	5	6	8	9	Mean	2	3
No. of stomata per unit area SE	26.4 *1.166	22.2 *0.663	19.8 *0.663	17 *1.00	25.4 *1.327	24.5 *0.748	22.55 *1.47	18.4 *1.470	20.8 *1.020
No. of stomata open	22 *0.707	19.8 *0.735	17.4 *0.674	14.2 *1.463	20.6 *1.166	19.6 *0.927	18.93 *0.945	14.4 *1.503	17.8 *1.114
Lngth of Stomata	9 *0.447	10 *0.632	11 *0.447	8.8 *0.583	9 *0.447	11 *0.447	9.8 *0.501	9.6 *0.748	10 *0.632
Width of open stomata with guard cells	7.2 *0.374	7.2 *0.735	10.4 *0.400	6.6 *0.600	7.4 *0.748	8.6 *0.600	79 *0.576	7.0 *0.447	7.8 *0.663
Width of stomatal pore without guard cells	3 *0.447	2.4 *0.245	2.6 *0.245	1.6 *0.245	2.2 *0.200	2.8 *0.374	2.43 *0.292	3.2 *0.374	2.0 *0.316
Width of closed stomata with guard cells	4.8 *0.374	4.4 *0.245	6.8 *0.374	4.2 *0.374	5 *0.316	5.4 *0.247	5.1 *0.322	4.8 *0.374	5.0 *0.447

*denotes SE ± = Standard Error

Note : Figures given in length and width od stomata are the parts (number) of the

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of the leaf from different sides of the crown, October, 1986.
Standard Error)

South Trees Nos.					West Trees Nos.						
5	6	8	9	Mean	2	3	5	6	8	9	Mean
24.8	25.2	21.2	19.8	21.70	22.4	22.2	22	32.8	18.4	24.4	22.2
*2.059	*0.583	*1.020	*1.281	*1.12	*1.166	*1.114	*0.707	*1.281	*0.678	*1.208	*0.85
21.2	20.6	18.2	16.8	18.17	18.8	18.8	19.2	22.4	15.4	18.6	18.86
*0·158	*0.400	*0.902	*1.281	*0.89	*0.583	*0.583	*0.860	*1.030	*0.812	*1.030	*0.816
8.6	10.8	9.2	9.2	9.57	7.6	10.0	9.8	12.0	8.4	10.6	7.93
*0.600	*0.374	*0.447	*0.347	*0.525	*0.678	*0.632	*0.490	*0.837	*0.570	*0.400	*0.601
7.4	9.2	8.4	7.8	7.93	7.0	8.2	8.8	9.4	5.8	9.2	8.06
*0.748	*0.374	*0.510	*0.800	*0.642	*0.447	*0.583	*0.583	*0.400	*0.663	*0.583	*0.543
2.0	2.6	3.0	2.0	2.43	2.8	4.8	5	3.6	2.2	2.2	3.43
*0.316	*0.245	*0.447	*0.316	*0.335	*0.374	*0.374	*0.316	*0.400	*0.200	*0.548	*0.368
4.8	5.2	5.4	5.6	5.13	5.2	2.2	2	5.0	4.4	6.0	4.13
*0.374	*0.374	*0.245	*0.245	*0.343	*0.372	*0.374	*0.316	*0.447	*0.445	*0.200	*0.358

ocular micrometer. The value of one part is 0.0025 mm or 2.5 μm.

Table 4

Mean values of various characters for trees and aspects separately.
(Derived from Table 3)

Characters	Trees						Aspects		
	T_2	T_3	T_5	T_6	T_8	T_9	E	S	W
No. of stomata/unit area	22.4	21.7	22.1	22.0	21.7	22.3	22.6	21.6	21.9
No. of stomata open	18.4	18.8	19.3	19.1	18.1	18.3	18.9	18.2	18.9
Length of stomata	8.73	10.00	9.80	10.53	8.80	10.27	9.80	9.53	9.73
Width of open stomata with guard cells	7.07	7.73	8.87	8.40	7.20	8.53	7.90	7.93	8.07
Width of closed stomata with guard cells	4.93	4.73	5.53	4.80	4.93	5.67	5.10	5.13	5.07
Width of stomatal pore without guard cells.	3.00	2.20	2.20	2.60	2.47	2.33	2.43	2.47	2.50

T—Tree No., E—East, S—South, W—West.

Acknowledgement

The authors are grateful to Dr. K.P. Unnikrishnan and Dr. Chaubey of Statistics Branch for statistical analysis of data.

SUMMARY

The stomatal studies were done on 10 trees of *Eucalyptus* hybrid selected at equal distance along a 3.5 km long transect in Tarai area of U.P. to determine under what conditions the species can tap the water table by deep rooting as alleged frequently. The results show that as such there is no co-relation between the tree position on transect and stomatal conductance. But the number of stomata open, the tree as well as surfaces show significant difference among themselves. For the character width of stomata, only tree effects are significantly different. For rest of the characters the factors under study are not significantly different even at 5% level of probability. However, on the basis of means, in general, the abaxial surface, top portion and mature leaf are having higher values than adaxial surfaces, basal portions and young leaves respectively. An analysis of variance was carried out to see whether the tree and aspect exhibit any significant difference in their effects on each of the characters studied separately. It was found that all the characters, the tree as well as aspects did not differ in their effect significantly.

उत्तर प्रदेश के तराई क्षेत्र से लिए गए अनुक्षेत्र में शंकर यूकेलिप्टस वृक्षों में मुख

एस० नौटियाल व ई०आर० सी०रेनाल्ड

सारांश

मुखों का यह अध्ययन उत्तर प्रदेश के तराई क्षेत्र के 3.5 किमी० लम्बे अनुक्षेत्र में बराबर-बराबर दूरी पर चुने गए 10 सकर यूकेलिप्टस वृक्षों पर उन दशाओं को विनिश्चित करने के लिये किया गया जिनमें यह वृक्ष जाति अपनी गहरी जड़ो द्वारा जल स्तर से जल प्राप्त कर सकती है जैसा बहुधा कहा जाता रहा है। परिणाम बताते हैं कि अनुक्षेत्र में वृक्ष की स्थिति और मुखों की संचालकता में दृश्यत: कोई सहसम्बन्ध नहीं है। परन्तु खुलन वालेमु खों की सख्या और वृक्ष के स्तरो मे परस्पर सार्थक अन्तर दिखाई देते हैं। मुख की चौड़ाई लक्षण में केवल वृक्ष पर पड़ प्रभावों में साथक अन्तर रहा है। शेष लक्षणों में इस अध्ययन में लिये गये अन्य कारकों में संभाव्यता के 5% स्तर पर भी कोई साथक अन्तर नहीं पाया गया। तथापि, मध्यों के आधार पर सामान्यत: अपाक्षीय स्तर, शीर्ष वाले भाग और वयस्क पत्तियों मे अभ्यक्षीय स्तर, आधार के निकट के भाग और नई पत्तियों की अपेक्षा क्रमश: अधिक उच्च मान प्राप्त हुए हैं। वृक्ष और उनके मुख का भी अध्ययन किए गए इन सभी लक्षणों पर अलग-अलग कोई सार्थक प्रभाव पड़ता है या नहीं यह मालूम करने के लिए विचर विश्लेषण भी किया गया। इसमें यह पाया गया कि इन सभी लक्षणों में वृक्ष और उसके मुख का उन पर पड़े प्रभावों में कोई सार्थक अन्तर नहीं पाया गया।

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USE OF MULCHES IN ESTBLISHMENT AND GROWTH OF TREE SPECIES ON DRY LANDS

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Introduction

Tree establishment is a crucial phase in successful afforestation of dry lands. Low and erratic rainfall, high temperature and intense radiations are the main hostile factors in dry zones which cause rapid drying and hardening of surface soil leading to high seedling mortality, making the tree establishment difficult. Use of mulches, water harvesting and chemical fertilizers in optimum doses are the various approaches of optimising soil physico-chemical environment on such lands for establishment and early growth of plants. Use of various types of mulches has been found to delay the process of soil drying by reducing evaporative loss of soil moisture (Prihar *et al.*, 1977, Gupta, 1983 and Gupta and Gupta, 1982, 1983).

Coir pith, which is a non-fibrous waste from coconut factories and is freely available in abundance in southern states, has good mulching properties. Therefore, effect of mulches was studied on tree establishment in clay loam soil of Bolampatti, clay soil of Coimbatore and degraded red sandy clay loam skeletally soil of Pethikuttai.

Materials and Methods

Field experiments were conducted in Coimbatore Forest Divn. at three locations : Mullangadu (Bolampatti Range), Pethikuttai (Mettupalayam Range) and Forest College Campus, Coimbatore. Soils of these sites are clay loam, sandy clay loam and clayey; respectively. Physico-chemical properties of experimental soils are given in Table 1. Rainfall at three sites, during the experimental period (tree establishment phase) is given in Figure 1. Treatments comprised of (i) no mulch and (ii) coir pith mulch + fertilizer (50 g superphosphate + 25 g urea/plant) at Mullangadu and Coimbatore. At Pethikuttai treatments were (i) no mulch and (ii) gravel mulch + water harvesting + fertilizer (50 g superphosphate + 25 g urea/plant). Number of tree species tried were 10 at Mullangadu, 3 at Coimbatore and 12 at Pethikuttai (Tables 2 and 3). Each treatment was replicated thrice. Each plot had 25 plants at 2 m × 2 m spacing. Pits of size 40 cm^3 were dug and required quantities of fertilizers were mixed with the pit soil and filled back. Three month old seedlings of all the tree species were planted in the month of November, 1985 at Coimbatore and Mullangadu. At Pethikuttai, 6 months old seedlings were planted in the month of February, 1986. Thereafter, mulch and water harvesting treatments were given after applying BHC (about 10 g/plant). Monthly

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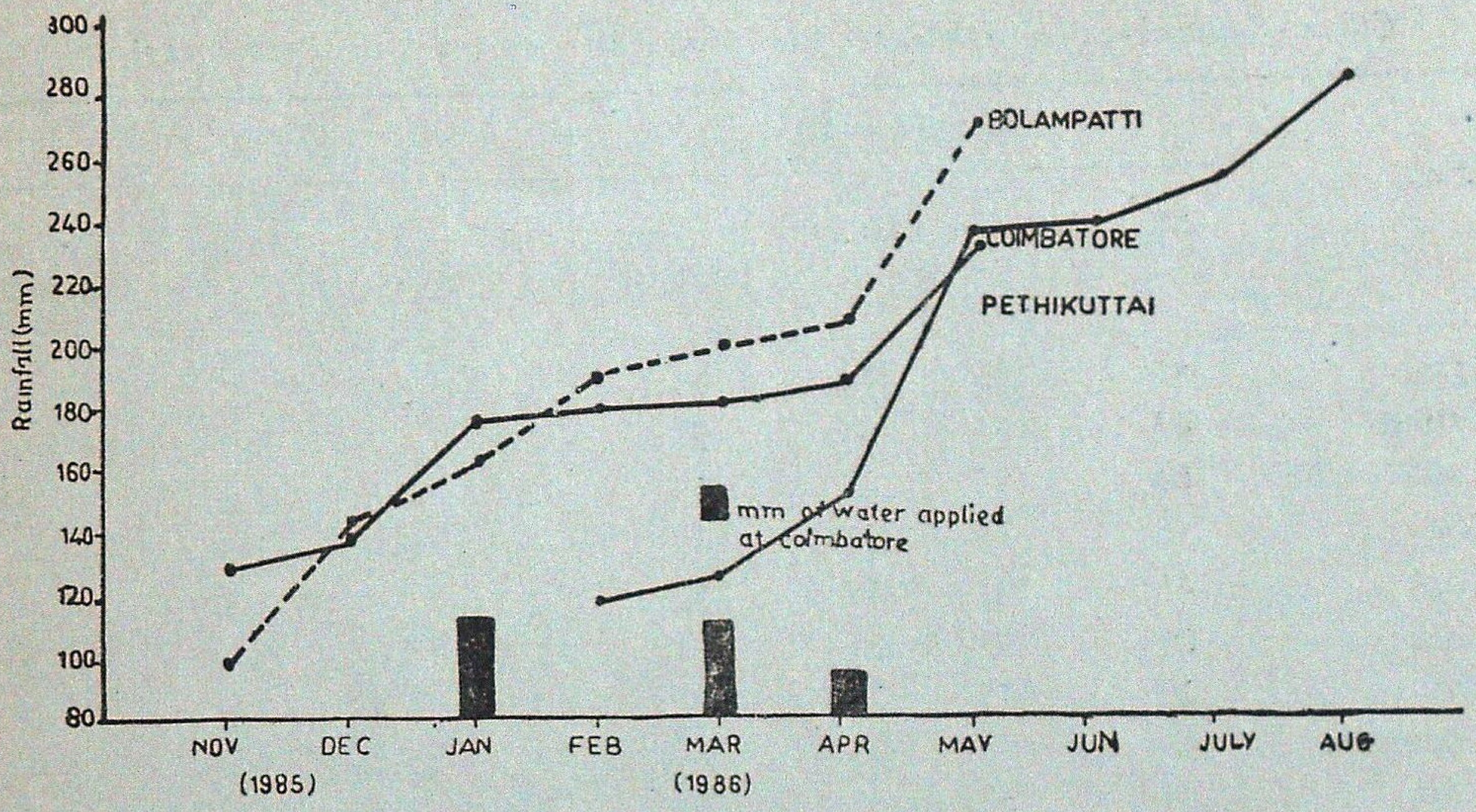
Table 1

Selected properties of the experimental soils

Properties	Coimbatore			Mullangadu			Pethikuttai		
	0-25 cm	25-50 cm	50-75 cm	0-25 cm	25-50 cm	50-75 cm	0-25 cm	25-50 cm	50-75 cm
Soil structure	$m_2$abk	$m_3$abk	$m_3$abk	$m_2$abk	$m_3$abk	$m_3$abk	$f_1$gr	$m_1$sbk	$m_1$sbk
Consistency	mfi	mvfi	mvfi	mfi	mvfi	mvfi	mfr	mfi	mfi
Coarse fragments	fgr	nil	nil	nil	nil	nil	fgr	pgr	pgr, fst
Textural class	c	c	c	cl	l	l	scl	scl	sl
Sand	23.4	21.7	24.2	38.4	36.4	40.2	71.4	70.0	68.9
Silt	7.6	12.3	8.8	32.6	42.6	28.8	4.6	5.0	11.1
Clay	69.0	66.0	67.0	29.0	21.0	31.0	24.0	25 0	20.0
pH	8.95	8.75	8.70	8.30	8.20	8.10	7.70	7.75	7.35
Organic Carbon (%)	1.64	0.86	0.97	1.44	1.13	0.94	0 08	0.20	0.20
P_2O_5 (kg/ha)	189.0	169.5	235.0	138.8	114.5	99 4	42.5	18.4	7.7
CEC (me%)	50.0	50.6	51.7	34 8	39.9	35.1	9.9	9.30	9.4
Moisture Retention (%)									
At 0.3 Bars	33.7	33.7	33.7	22.5	27.4	26.95	10 34	13.15	9.0
15.0 Bars	24.7	24.7	24.7	14.4	17.5	17.0	5.6	7.9	5.0
Solum depth		105			86			62	

Fig. 1



Rainfall (mm) of experimental sites.

Table 2

Height (cm) of 6 month old tree species as affected by coir pith mulch.

Species	Mullangadu				Coimbatore			
	M_0	M_1	Mean	Per cent increase	M_0	M_1	Mean	Per cent increase
A. nilotica	25.9	50.7	38.3	96	—	—	—	—
A. planifrons	19.2	40.9	30.1	113	—	—	—	—
E. camaldulensis	27.5	43.1	35.3	57	102	120	111	18
T. indica	18.0	20.4	19.2	13	91	98	95	8
A. lebbeck	10 7	9.3	10.0	–13	—	—	—	—
P. pinnata	18.4	18.7	18.6	2	—	—	—	—
A. indica	10 2	16.3	13.3	60	—	—	—	—
P. pterocarpum	18.1	33.4	25.8	85	—	—	—	—
E. cuminii	17.1	16.9	17.0	–1	—	—	—	—
A. leucophloea	11.7	14.9	13.3	27	—	—	—	—
C. equisetifolia	—	—	—	—	115	147	131	28
Mean	17.7	26.5			103	122		
C.D. 1%	Species 4.14	Mulch 9.25	Species×Mulch 13.1		Species 9.70	Mulch 11.88	Species×Mulch 16.80	

Table 3

Effect of gravel mulch with water harvesting on tree species at Pethikuttai

Species	Height (cm)				Girth (cm)			
	M_0	M_1	Mean	Per cent increase	M_0	M_1	Mean	Per cent increase
A. nilotica	51	100	76	96	2.5	5.9	4.2	136
A. planifrons	43	65	54	51	2.2	4.7	3.5	114
E. camaldulensis	64	98	81	53	2.4	4.6	3.5	92
T. indica	18	23	21	28	1.5	1.4	1.5	-7
A. lebbeck	45	102	74	122	2.7	3.9	3.3	44
P. pinnata	29	33	31	14	2.5	3.0	2.3	20
A. indica	22	35	29	59	2.0	2.4	2.2	20
P. pterocarpum	43	82	63	91	3.7	5.2	4.5	41
E. cuminii	29	32	31	10	1.4	2.2	1.8	57
A. leucophloea	44	74	59	68	2.6	3.0	2.8	15
C. equisetifolia	21	30	26	43	1.6	2.4	2.0	50
C. pentandra	60	88	74	47	3.6	5.9	4.8	64
Mean	36	64			2.4	3.7		
C.D. 1%	Species	Mulch	Species × Mulch		Species	Mulch	Species × Mulch	
	6.8	16.7	23.6		0.6	1.4	1.9	

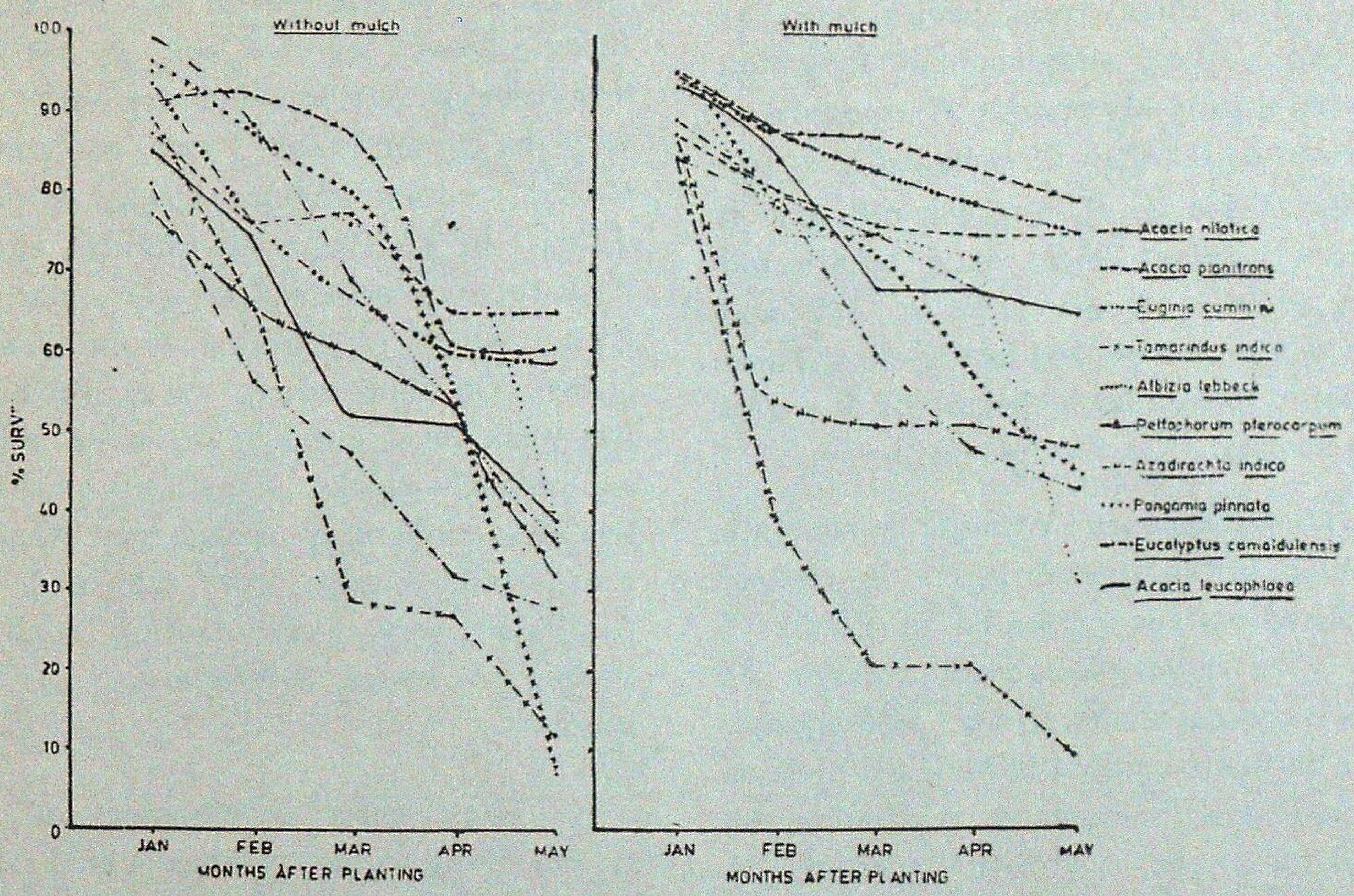
soil moisture observations were recorded gravimetrically in 0-25, 25-50 and 50-75 cm layers at all the three locations. Soil temperature at 5 and 15 cm depths were recorded periodically by digital temperature recorder at Coimbatore experimental site. Monthly observations on seedling survival were recorded at Mullangadu. Plant height was recorded 4, 5 and 6 months after planting at Mullangadu, 3, 4 and 6 months after planting at Pethikuttai and only after 6 months at Coimbatore.

Results and Discussion

Plant Survival : At Mullangadu, severe drought prevailed after planting the tree species setting in a varying degree of soil moisture stress, with the result young seedlings started wilting. The tree species which suffered higher mortality with rapid drying of soil profile are *T. indica*, *E. cuminii*, *A. lebbeck*, *P. pinnata*, *E. camaldulensis*, *A. indica* and *A. leucophloea* (Figure 2). Whereas, *P. pterocarpum*, *A. nilotica* and *A. planifrons* exhibited maximum tolerance to moisture stress and their per cent survival was 67, 59 and 67 respectively.

Use of coir pith mulch played a dramatic role in preventing high mortality of tree species and enhanced survival of *E. camaldulensis* from 28 to 65%, *P. pterocarpum* from 67 to 79%, *A. nilotica* from 57 to 75%, *A. planifrons* from 67 to 75%,

Fig. 2



Tree survival as affected by soil drying and mulch.

A. leucophloea from 38 to 65%, *A. indica* from 32 to 48% and *P. pinnata* from 7 to 45%. Seedlings of *T. indica*, *E. cuminii* and *A. lebbeck* did not respond to mulch application.

Plant Height : Though total rainfall received during the experimental period was nearly same (272 and 295 mm, respectively) at Mullangadu and Pethikuttai sites, the plant height was very poor on clay loam soil of Mullangadu, where the survived seedlings were stunted in untreated plots whereas on sandy clay loam soil of Pethikuttai, height of control plot was much better (Table 2 and 3). Use of coir pith mulch showed significant influence on the height of *A. nilotica*, *A. planifrons*, *E. camaldulensis* and *P. pterocarpum* which had nearly double the height in control after 6 months at Mullangadu (50.7, 40.9, 43.1 and 33.4 cm as compared to 25.9, 19.3, 27.5 and 18.1 cm in control).

Influence of gravel mulch + water harvesting was tremendous on growth of 10 of the 12 tree species tried at Pethikuttai (Table 3). Plant height after 6 months of planting was doubled due to mulching in *A. nilotica* (51 to 100 cm), *A. lebbeck* (45 to 102 cm) and *P. pterocarpum* (43 to 82 cm). The relative increase in height was of the order of 43 to 68% in other tree species except *T. indica*, *P. pinnata* and *E. cuminii* which did not respond to mulching with water harvesting treatments. There was 41 to 136% increase in tree collar circumference of eight out of twelve tree species due to mulching and water harvesting treatments at Pethikuttai (Table 3). Collar circum-

ference of other species were less than 20%.

Out of three tree species tried at Coimbatore, where supplemental irrigation was given during dry periods, *C. equisetifolia* performed better than *E. camaldulensis* and *T. indica* (Table 2). Use of coir pith mulch increased the plant height of 6 month old *C. equisetifolia* from 115 to 147 and *E. camaldulensis* from 102 to 120 cm. There was slight increase in the height of *T. indica* (91 to 98 cm).

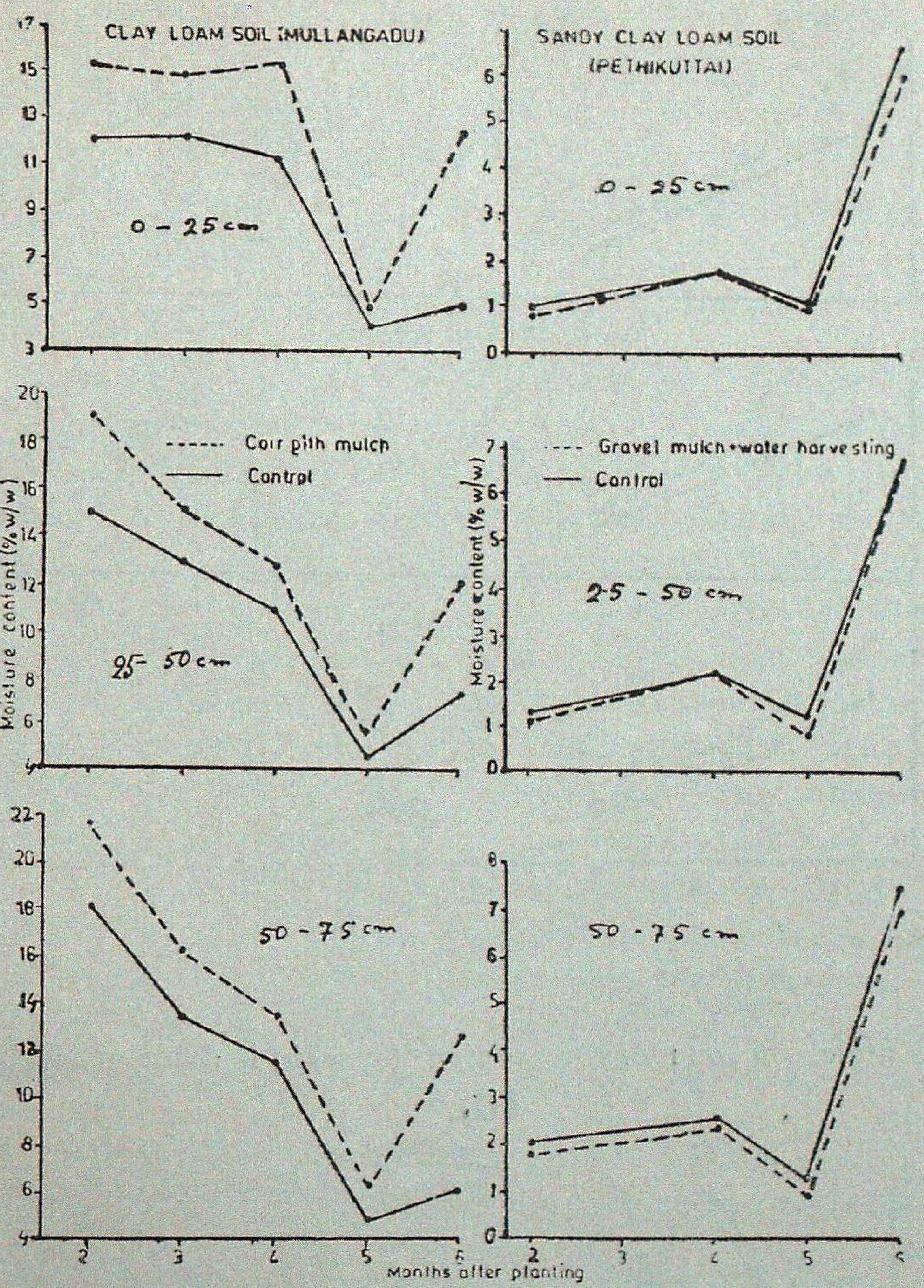
Soil Moisture Regimes : Variation in moisture content in different soil layers in control and treated plots is presented in Figures 3 and 4. The values plotted are average of moisture content under all the tree species. Higher moisture content in mulched plots as compared to unmulched was observed throughout the growth period at Mullangadu. In driest month of April, where sudden drop in plant survival was noted, mulched plots maintained higher moisture content by a magnitude of 25% in surface layer and 30 to 32% in sub-surface layers. Interestingly at Pethikuttai site, treated plots (gravel mulch + water harvesting) had slightly lower moisture content than control plots (Fig. 3). This may be attributed to higher consumptive loss of moisture by plants in treated plots where the plant growth was manyfold higher than the control. In general, Soil moisture content values at Pethikuttai were much lower than at Mullangadu. This is due to poor soil moisture storage capacity of the former.

However, plant performance on sandy clay loam soil of Pethikuttai was much better than on clay loam soil of Mullangadu. A high degree of mechanical impedance appears to be the main reason for poor survival and growth of tree species at Mullangadu. Being a heavy textured soil, it has moist firm to moist very firm and dry hard to dry very ha d consistency and moderate to strong medium angular blocky structure. This is an unfavourable physical environment for root penetration, particularly for a plant which is suffering from moisture stress. On the contrary, soil at Pethikuttai has weak fine granular to weak medium sub-angular blocky structure and moist friable to moist firm consistency where the roots could easily proliferate and thus facili a.ed very good rooting conditions leading to better development of root system.

Thus, early development of root sys em owing to the reasons stated above, coupled with easy availability of moisture at Pethikuttai led to early establishment and growth of all the tree species than at Mullangadu. This physico-chemical environment was further optimised by use of gravel mulch+water harvesting.

The variation in moisture content in clayey soil of Coimbatore under three tree species is presented in Figure 4. Significantly higher moisture content was observed in mulched pits than unmulched ones, throughout the growth period. Conservation of moisture was more in surface layer; where the per cent moisture in mulched pits was 30.3, 28.5 and 30.3; respectively under *T. indica*, *E. camaldulensis* and *C. equisetifolia* compared to 27.5, 22.5 and 24.7%; respectively in unmulched pits, in the month of March. While comparing various tree species, lowest moisture content during the period January to March (1st dry phase)

Fig. 3



Effect of mulches and water harvesting on soil moisture content in different layers.

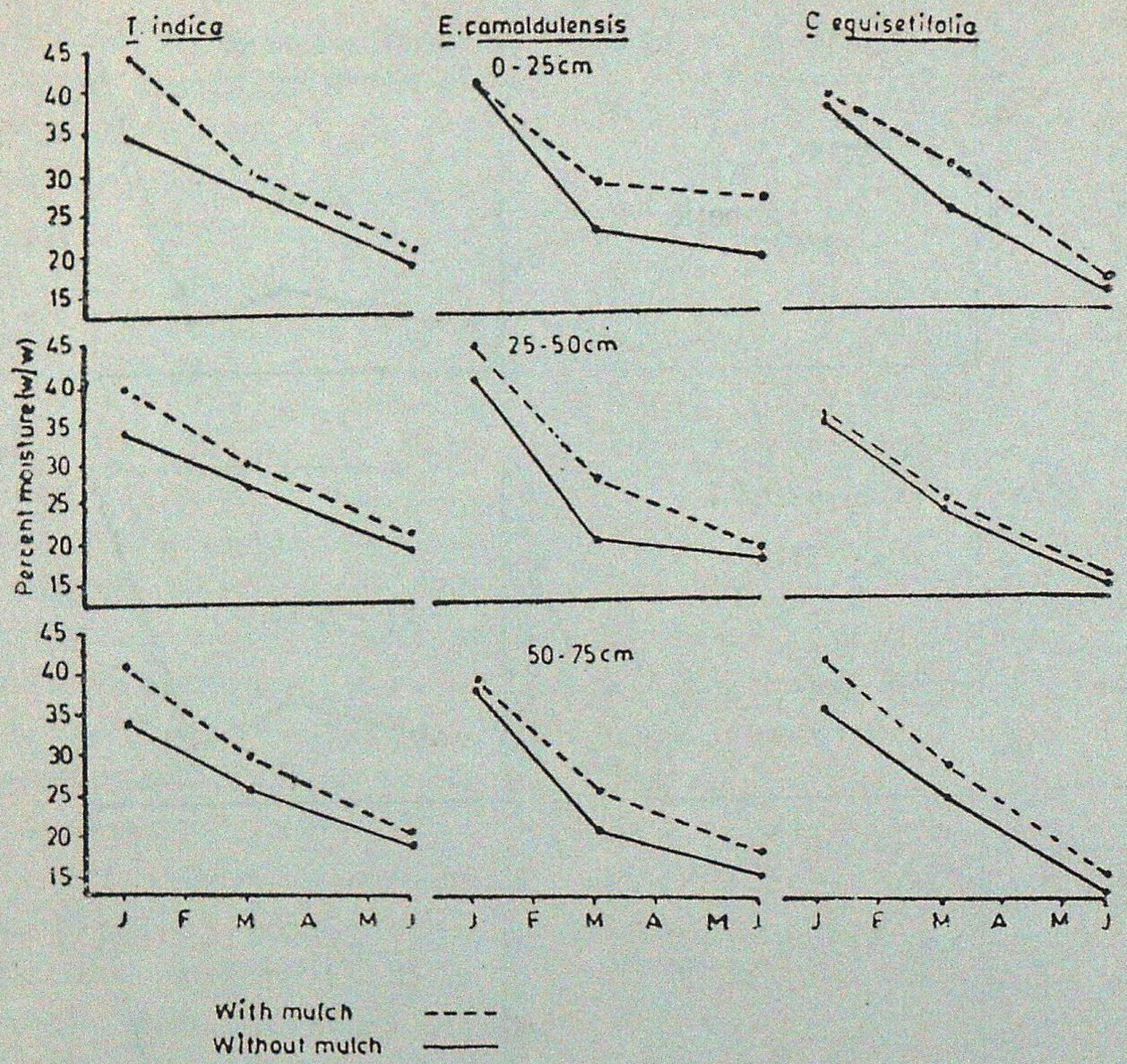
was noted under *E. camaldulensis*. However, in subsequent period from March to June rate of drying was faster under *C. equisetifolia* which may be attributed to faster growth rate in later phase than other two species.

Soil Temparature : Maximum soil temperature at 5 and 15 cm depths was recorded periodically at Coimbatore site (Figure 5). It was noted that coir pith mulch helped moderating thermal regimes of soil by bringing down soil maximum temperature. Use of mulch lowered the soil temperature as much as by 4°C under *E. camaldulensis* and 3°C under *T. indica* and *C. equisetifolia* at 5 cm depth. This moderating effect of mulch on thermal environment of soil continued at 15 cm depth with lower magnitude.

Conclusion

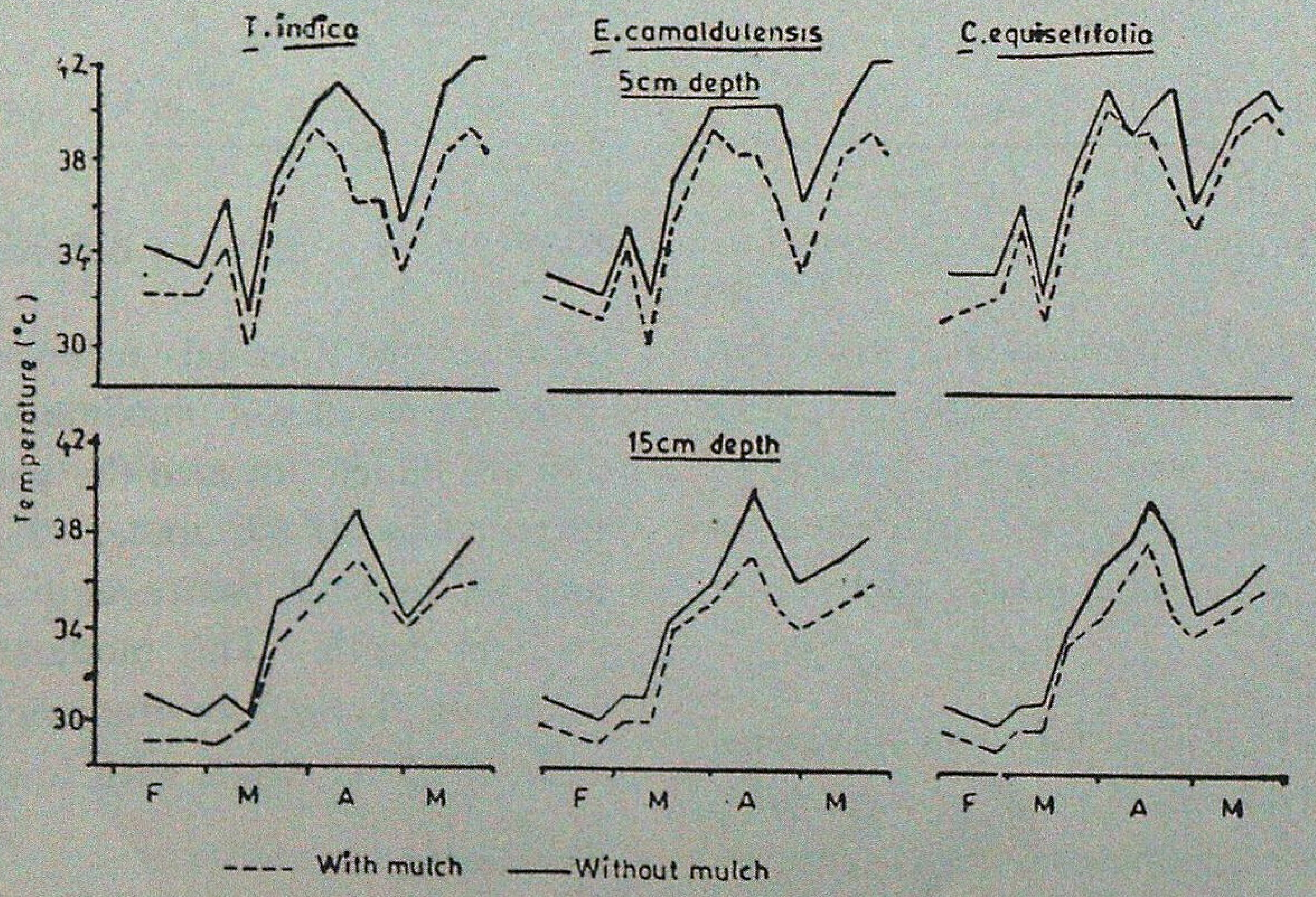
From the results of this study it is

Fig. 4



Effect of coir pith mulch on soil moisture content (% w/w) in different layers at Coimbatore.

Fig. 5



Effect of coir pith mulch on soil temperature (°C) at Coimbatore.

concluded that use of coir pith mulch or gravel mulch and water harvesting coupled with optimum dose of fertilizers play a very vital role in establishment and early growth of tree seedlings in dry zones. Further, all the tree species tried performed better on sandy clay loam than clay loam soil indicating that mechanical impedance is the important factor limiting establishment of tree species, particularly on dry lands. This gives a clue for studying preplant soil operations to facilitate better root penetration in fine textured soils.

SUMMARY

Field experiments at three locations, namely Bolampatti, Pethikuttai and Coimbatore (Coimbatore Forest Division, Tamil Nadu) having different rainfall pattern and soils were conducted in 1985-86. Coir pith mulch was used on heavier soils of Bolampatti and Coimbatore, while gravel mulch was used on medium soil of Pethikuttai. Height of *A. planifrons* (113%), *A. nilotica* (96%), *P. pterocarpum* (85%), *A. indica* (60%) and *E camaldulensis* (57%) increased due to coir pith mulch treatment. Response to mulch treatment was not so marked in case of *A. leucophloea* (27%) and *T. indica* (13%). *A. lebbeck*, *E. cuminii* and *P. pinnata* did not respond to treatment. At Pethikuttai, use of gravel mulch increased height of *E. camaldulensis* (53%), *A. indica* (59%), *C. pentendra* (47%), *A. leucophloea* (68%) and *A. nilotica* (96%), *A. planifrons* (51%), *P. pterocarpum* (91%) *A. lebbeck* (122%). Growth of *E. cuminii*, *C. equisetifolia*, *P. pinnata* and *T. indica* was not significant due to mulch. At Coimbatore, where additional water was also given during severe moisture stress, plant height of *C. equisetifolia* increased from 115 to 147 cm, *E. camaldulensis* from 102 to 120 cm in 6 months after planting. *T. indica* did not respond to mulch application at this site. Use of coir pith mulch maintained significantly higher moisture regimes at all the locations throughout the growth period Coir pith mulch reduced the surface soil temperature by 3 to 5°C at Coimbatore.

शुष्क क्षेत्रों में वृक्ष जातियों की स्थापना और वृद्धि पर छाद्यावरण का उपयोग करना

बलविन्दर सिंह, जी०एन० गुप्त, के०जी० प्रसाद व एस० मोहन

सारांश

वर्षा की भिन्न–भिन्न सज्जा और मृदाओं वाले तीन स्थानों अर्थात बोलमपट्टी, पेथीकुट्टई और कोयम्बटूर (कोयम्बटूर वन मण्डल, तमिलनाडु) पर 1985–86 में कुछ क्षेत्र परीक्षण किये गए। बोलमपट्टी और कोयम्बटूर की अपेक्षतया भारी मृदाओं में नारियल जटा का तथा पेथीकुट्टई की मध्यम मृदा पर बजरी का छाद्यावरण उपयोग किया गया। नारियल की जटा उपचार मे ऊंचाई अ० प्लेनिफ्रोंम (113%), अ० नीलोटिका (96%), पी० टेरोकार्पम (85%), ए० इण्डिका (60%) और यू० कैमेलड्यूलेंसिम (57%) बढ़ी। छाद्यावरण उपचार का प्रतिचार अ० ल्यूकोफिलआ (27%) और टै० इण्डिका (13%) में इतना अच्छा नहीं रहा और ए० लेब्बेक, यु० क्यूमिनाई और पी० पिन्नेटा में तो उपचार का प्रतिचार ही नहीं हुआ। पेथीकुट्टई में बजरी का छाद्यावरण उपयोग करने से ऊंचाई यू० कैमेलड्यूलेंसिस (53%), ए० एण्डिका (59%), के० पेंटेण्ड्रा (47%), अ० ल्यूकोफिलआ

(68%) और अ० नीलोटिका (96%), अ० प्लेनिफ्रोंस (51%), पी० टीरोकार्पम (91%) और ए० लेब्बेक (112%) बढी । यु० क्यूमिनाई, कै० इक्विसेटिफोलिया, पी० पिन्नेटा और टै० इण्डिका में छाद्यावरण से हुई वृद्धि सार्थक नहीं रही। कोयम्बटूर में, जहां नमी की कमी अधिक बढ जाने पर सिंचाई भी की गई कै० इक्विसेटिफोलिया की ऊंचाई लगाने के बाद 6 मास में 115 से बढ़कर 147 सेमी०, यु० कैमेलड्युलेंसिस की 102 से बढ़कर 120 सेमी० हो गई। इस जगह छाद्यावरण का टै० इण्डिका पर कोई प्रतिचार नहीं हुआ। नारियल जटा छाद्यावरण उपयोग करने पर सभी स्थानों पर वृद्धि की पूरी अवधि के दौरान सार्थक अधिक नमी स्तर बना रहा। नारियल जटा उपयोग करने से स्तर मृदा का तापमान कोयम्बटूर में 3° से 5° से० तक कम हो गया।

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STUDIES ON DORMANCY AND TREATMENT TO ENHANCE GERMINATION OF CHAMPA (*MICHELIA CHAMPACA*, LINN.) SEED

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Introduction

Delayed and erratic germination of champa seed is a serious problem in uniform seedling production as well as in efficient nursery management. In laboratory, it is also difficult to get an accurate estimation of germination potential of a seed lot.

Norman (1971) performed preliminary studies on champa seed by assuming impermeability of seed coverings as a germination barrier, but still the factors involved for delayed and poor germination are not properly understood. Present investigation was, therefore, taken up in order to resolve (i) the specific type of dormancy present in the seed and (ii) to determine optimum treatment to enhance germination.

Material and Methods

Depulped seeds extracted from the fresh fruits were taken for the study. An initial assessment of viability was made by cutting test and seeds with sound white endosperm were counted as viable.

Treatments : Prior to sowing seeds were made permeable by mechanical scarification, boiled water (5 min.), sulphuric acid (5 min.) and complete removal of seed coat. Prechilling treatment was given at 5°C for periods from one to seven months. Seeds were also treated with 250 ppm GA_3 for 24 hrs.

Following the results obtained from above treatments, further investigations were taken up to determine optimum GA_3 concentration and duration of treatment for maximum utilization of germination potential of this seed. Again fresh seeds were collected and soaked in 0, 10, 50, 100, 300, 500, 750 and 1000 ppm of GA_3 solutions for 24 hrs and 45 hrs prior to sowing.

Germination test : Four replicates of 100 seeds each were taken for each treatment and germinated in enamelled trays using sterilized quartz sand. All the trays were kept in a walk-in-germination room maintained at 30°C with 7 hrs light. Watering was done as and when required and germination was recorded daily till 60 days. Mean of four replicates was taken for total germination and expressed in percentage. Speed of germination was calculated in terms of germination value (GV) according to Czabator (1962).

Results and Discussion

M. champaca produces seeds with high percentage of fertility. Above 90% seeds were found filled and sound in the lots used for the study. Seeds in control exhibited only 2% germination.

Effect of various treatments on seed germination : All the coat softening treatmen's failed to improve germination. Even seeds in which coat was completely removed showed no sign of gemination. Seeds prechilled at 5°C exhibited little improvement in germination (Table 1). Germination gradually increased with the duration of treatment upto 4 months after which it declined probably due to loss of viability over a period of time. Seeds treated with GA_3 gave 62% germination.

Table 1

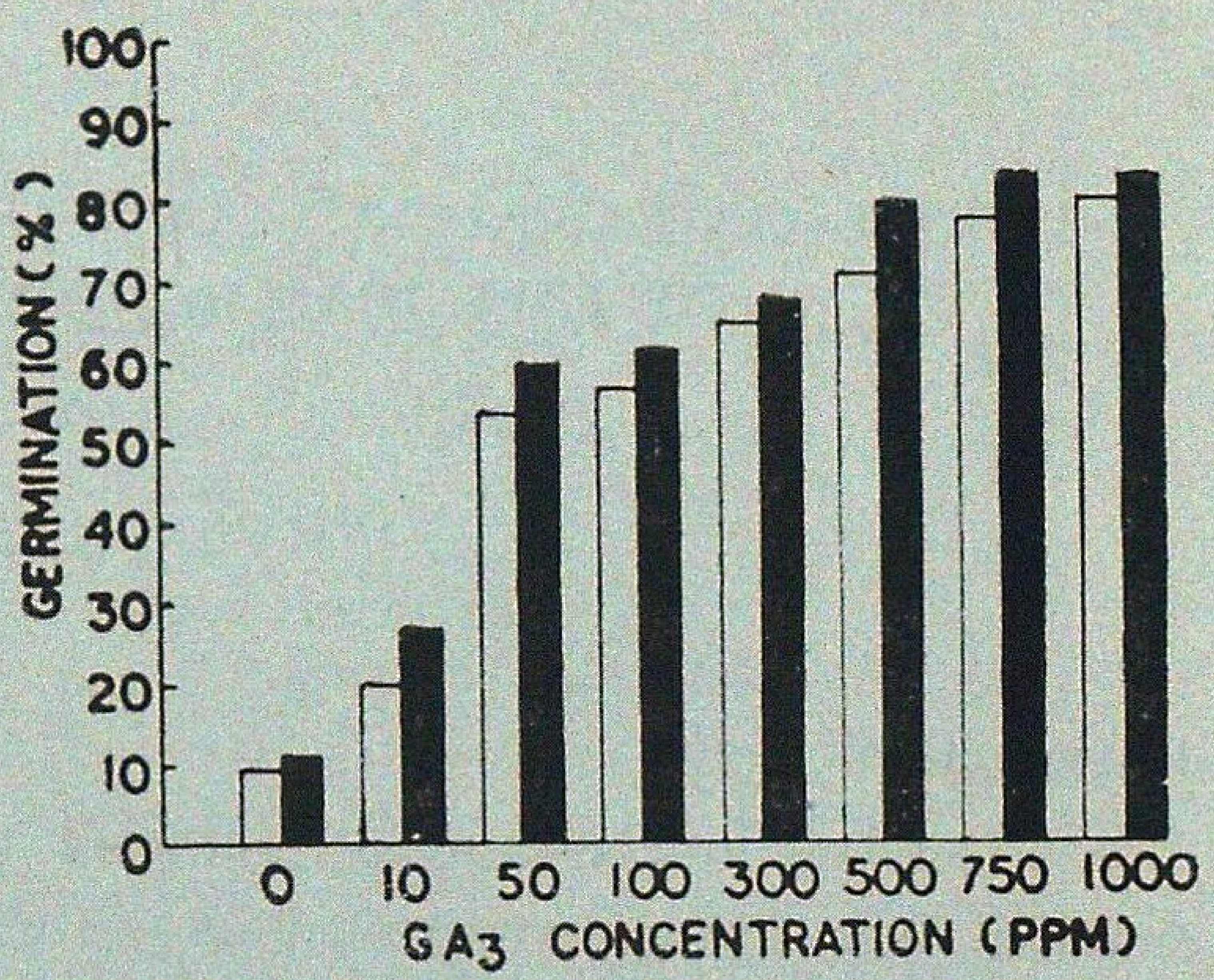
Effect of duration of prechilling (5°C) on germination of M. champaca seeds.

Duration of prechilling (months)	0	1	2	3	4	5	6	7
Germination(%)	2	20	24	33	36	32	12	7

Effect of various GA_3 concentrations and duration of treatment of on seed germination : GA_3 even in minute quantity was found capable of promoting germination but a steady enhancement became apparent with an increase in concentration (Fig. 1 and 2). Highest germination was obtained by treating seeds with 500 ppm GA_3. Further increase in concentration did not significantly improved germination. However, highest rate of germination (GV) was found in seeds treated with 750 ppm and 1000 ppm GA_3.

There was no significant difference in total germination of seeds treated for 24 hrs. and 48 hrs but GV was influenced significantly. Seeds treated for 48 hrs gave comparatively higher GV. Seeds soaked in water for 24 hrs and 48 hrs exhibited little improvement in germination.

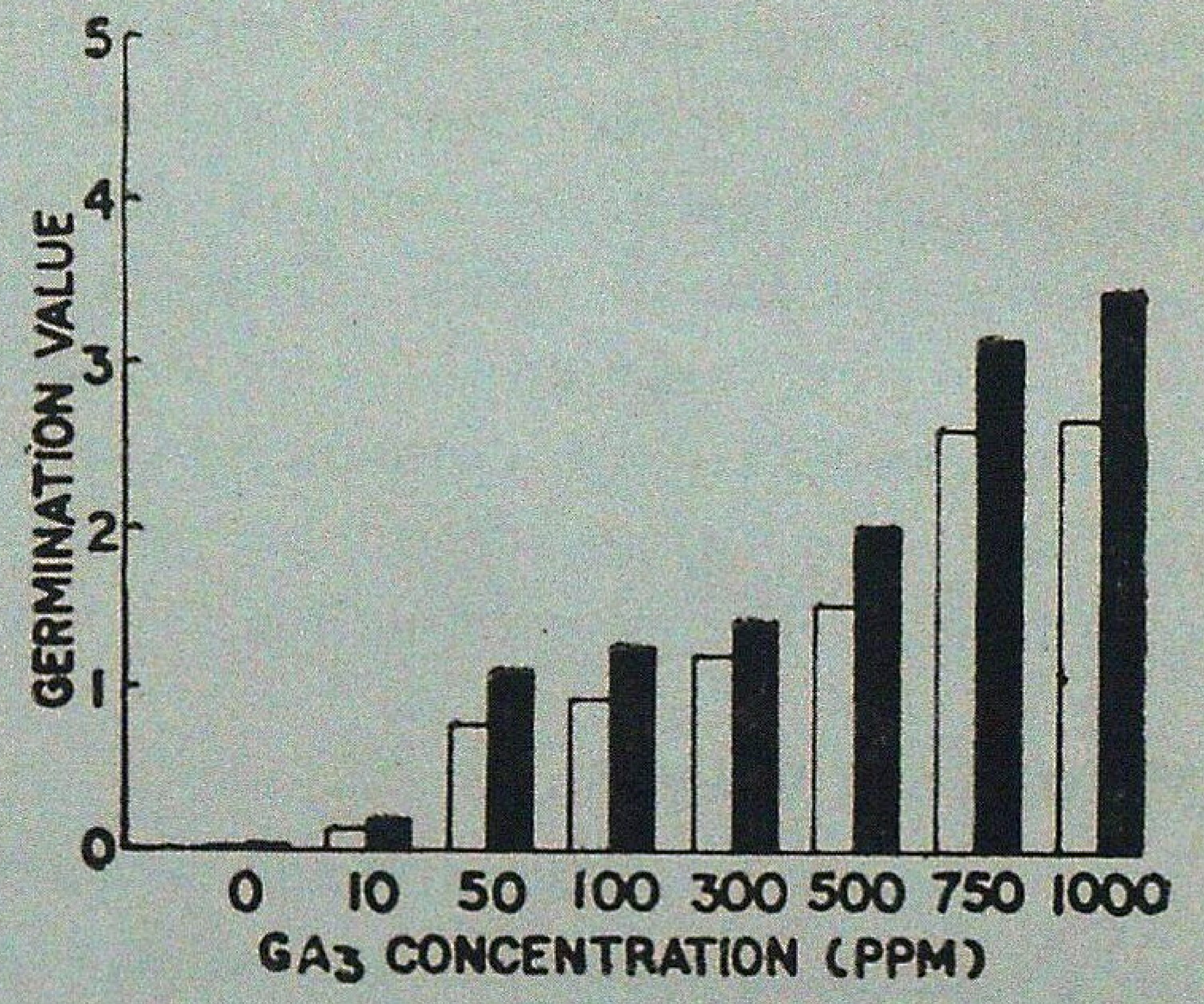
Fig. 1



Effect of various concentrations of GA_3 and duration of treatment on total germination of *M. champaca* seeds.

(White bar : 24 hrs and black bar : 48 hrs)

Fig. 2



Effect of various concentrations of GA_3 and duration of treatment total on germination value of *M. champaca* seeds.

(White bar : 24 hrs ahd black bar : 48 hrs)

On the basis of these results it can be safely assumed that the seed coat, though moderately hard, is not responsible for delayed germination. The seed of champa

seems to be physiologically dormant at the time of shedding. The effect of GA_3 in breaking of dormancy further supports the idea. Prechilling, however, did not reliably break dormancy in champa seeds, but the little improvement in germination can be attributed to the synthesis of growth hormones, like gibberellin during the process. The prechilling treatment applied for breaking dormancy increases the endogenous gibberellin activity and thereby stimulate enzyme activity (Gasper *et al.*, 1975).

SUMMARY

Seed of *Michelia champaca* were treated variously to enhance germination. All coat softening treatments failed to improve germination. Little improvement in germination was observed in seeds prechilled at 5°C. Gibberellic acid was found effective in promoting total germination as well as speed of germination in terms of germination value.

चम्पा (माइकोलिया चम्पका लि०) बीजों को सुषुप्ति और उनका अंकुरण
बढ़ाने के उपचार सम्बन्धी अध्ययन

वी०के० बहुगुणा, एम०एम० रावत व के०सी० मैठाणी

सारांश

अंकुरण बढ़ाने के लिए माइकोलिया चम्पका के बीजों का कई तरह से उपचार किया गया। पूरे आवरण को नरम बनाने के उपचार अंकुरण बढ़ाने में विफल रहे। 5^0 से० पर ठंडे किये बीजों को बोने पर अंकुरण में मामूली सा परिष्कार आता देखा गया। कुल अंकुरण तथा अंकुरण अर्हा के रूप में अंकुरण की गति बढ़ाने में जिबेरेलिक अम्ल का उपयोग प्रभावकारी पाया गया।

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INVESTIGATING THE WATER-TABLE UNDER *EUCALYPTUS* HYBRID BY RESISTIVITY METHOD

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Introduction

Ecologically phreatophytes are those plants which are adapted to grow under the influence of phreatic water, that is, with their roots in persistent proximity to the water-table. The hydrologist on the other hand means the riparian vegetation and any other patches which are consistantly supplied with water from the water-table In estimating the water balance, such areas are treated distinctively; their evapotranspiration is independent of fluctuating available soil moisture. As the evaporative demand of the atmosphere can be met by these plants, there is no need for them to conserve water by limiting transpiration. It follows that the yield of streams can be increased simply by controlling riparian vegetation and favouring shallow rooted plants in the valley bottoms. It is, therefore, of paramount importance that we should know what constitutes phreatophytic vegetation. More pertinently, under what conditions does *Eucalyptus* hybrid exhibit the phreatophytic characteristic of obtaining water freely for maximal transpiration from the water-table.

We are confronted with many conflicting assertions about the depth of rooting of the *Eucalyptus* as well as about the water-table and its seasonal fluctuation. Our real concern is whether the two are effectively related. Some of the confusion arises from uncritical deductions based on observation of water table behaviour which fails to take into account abstraction of water from wells for irrigation, industrial or urban use. Such withdrawal causes a depression of the water-table for a sizeable area around; recovery of the water level when pumping ceases is an adjustment of levels over a still wider area. Sometimes wells tap aquifers which are far below the superficial water-table with which plant roots are associated, and interpretation of such systems is irrelevant to the question we have posed.

It is obvious that the evidence for *Eucalyptus* on a specific site being phreatophytic must avoid all the extraneous considerations and concentrate on assessing effects on water-table behaviour which are uneqivocal. This has been our approach in *Eucalyptus* of 1970 at the end of its first coppice rotation in the Western Circle, Tarai East Division, Kishanpur Range, Horai Block, Compartment-3A (10 km East of Lalkuan).

Season: During the first visit to the

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location (20-28 June, 1986) before the main monsoon, 65 mm of rainfall took place, The maximum temperature was usually in excess of 30°C (and reached 37°C) and the minimum did not fall below 22°C. The second visit (22-30 Oct., 1986) was after the monsoon. October was an abnormally dry month (29 mm) with only one very wet day (25 mm, 16 Oct.). By the last 10 days afternoon R.H. had fallen below 15%. Maximum temperature by now did not exceed 30°C, but minimum temperatures hardly fell below 13°C. Thus evapotranspiration could be expected to be quite large. (Met. data from the Crop Res. Centre, Pantnagar, 13 km S.W.).

Table 1

Maximum and minimum mean monthly water-table: Months (1 to 12) and depths (m)

Location	Maximum		Minimum	
	Months	Depth	Months	Depth
Lalkuan	6, 8, 9, 11, 12	9.3	4	8.4
Pipalparao	7	4.4	9, 10	4.0
Gangapur	5, 6	1.2	8	0 5

Source : 1975/6-1984/5 Working Plan, Terai & Bhabar Forest Division.

Site: The Tarai in this region (79°17'E; 29°4'N) slopes down Southwards at an inclination of 8 m/km in the North but only 3.5 m/km in the South. More or less parallel streams and nalas run from North to South. A transect of 3.4 km in length at 160° from North was laid outin silviculturally uniform *Eucalyptus* hybrid. Although the North end of the transect was around 256 m and the Southerly point 236 m, the drainage pattern produced numerous minor undulations. At approximately equal distances along the transect 10 locations were selected for study. The soils of the area come under the category coarse-loamy Fluvaquentic Hapludolls (Soil Taxonomy 1975) with the soils of the Northern end (locations 1 to 5) of predominantly sandy loams texture and the rest deep brown silty loam texture. The description of a representative soil profile has been given in Table 2 (A and B).

Methods

Inspection wells: In late June 1986 a well was dug at location 4 around 2.1 m deep and 1 m diameter. In late October 1986, 15 cm diameter wells were bored with a manual augar at the other locations. Water was found in all of these except the most Northerly (No. 1), where stones (presumably of the Bhabar formation) were encountered at 2.5 m. A Stevens Water Stage Level Recorder was emplaced at five selected wells for one or two days. Wells were also measured manually on two or three occasions between 0900 hr and 1800 hr on certain days during the two periods when the transect was studied.

Earth resistivity measurement: Because moisture in the earth's surficial layers considerably alters the resistance to current flow, it is possible to investigate the depth of the water-table by assessing the resistance of successively thicker layers by moving a pair of current electrodes further and further apart (see White, 1985 and Dhawan, 1986 for further details). A direct current is

Table 2

Reduction of information from water level, charts on selected wells in the Tarai Late October, 1986

	2	3	4	5	7
Water-table depth (m)	1.67	2.14	1.40	1.62	2.41
Dates recorder in use (Oct.)	25-26	29-30	23-25	26-28	28-29
Rise (r) or fall (f) in 24 hr (mm)	f 1.5 —	nil —	r 1.0 r 10.0	nil r 1.0	r 25.0 —
Oscillation in 24 hr (mm)	5.0 —	7.0 —	2.0 rising	3.0 1.4	Continuous rise —
Time of deepest water-table (hr)	1200-1430 —	1230-0710 —	1500-1800 rising	1700-2000 1700-2200	—
Time of shallowest water-table (hr)	1900-2400 —	0130 —	rising —	1100 1000-1600	—
Time of max. rate of fall (hr)	0300-0400 —	0400-0430 —	1100 1700-2000*	1215 1600	2400-0700* —
Time of max. rate of rise (hr)	1500-1700 —	1500-1600 —	1000-1100 0300	0330 0230	1730-1900 —

* Minimum rate of rise.

Table 3A

Physico-Chemical characteristics of soils

Depth (cm)	>2 mm (%)	Colour		Mechanical composition (%)			pH 1 : 2.5	Organic C (%)	Remarks
		Field	Dry	Sand	Silt	Clay			
1–10	23	10 YR 4/2	10 YR 6/3	59	26	14	5.5	1.18	—
10–30	9	10 YR 4/1	10 YR 6/4	52	30	18	5.7	0.84	—
30–50	13	10 YR 4/3	10 YR 6/4	56	26	18	5.7	0.48	—
50–73	14	10 YR 4/4	10 YR 6/6	49	29	22	5.6	0.42	—
73–101	12	10 YR 5/4	10 YR 6/6	50	25	22	5.7	0 32	Faint iron mottles
101–161	26	10 YR 5/4	10 YR 6/6	63	19	14	5.7	0.18	-do-
161–180	18	10 YR 5/6	10 YR 6/6	73	16	11	6.1	0.2	Prominent iron mottles

Table 3B

Exchangeable cation characteristics of soil

Depth (cm)	C.E C. (m.e %)	Base saturation (%)	Exchangeable cations m.e. (%)			
			Ca	Mg	Na	K
0— 10	9.2	40	2.00	1.42	0.02	0.27
10— 30	10.5	44	2.20	2.21	0 02	0.21
30— 50	7.7	48	1.55	1.92	0.02	0.21
50— 73	7 3	60	1.65	2 42	0.02	0.29
73—101	7.7	51	1.55	2.13	0.02	0.23
101—161	5.8	50	1.10	1.71	0.02	0.09
161—180	6.5	52	1.20	2 09	0.02	0.06

passed between these and the rate of voltage drop along this line measured independently with a pair of non-polorising electrodes relatively closely spaced on either side of the centre of the array (the so called Schlumberger arrangement of electrodes). The equipment used was a Power Pack-60 and a separate voltmeter (Jaks Elec.ronic Systems, Hyderabad), Currents used were less than 100 mA and the applied voltages upto 260V D.C. with a power of 6 W. The earth resistivity was investigated at locations 1, 3 and 9 along the transect, the water-table being independently measured in the inspection wells except in the dry well at location 1.

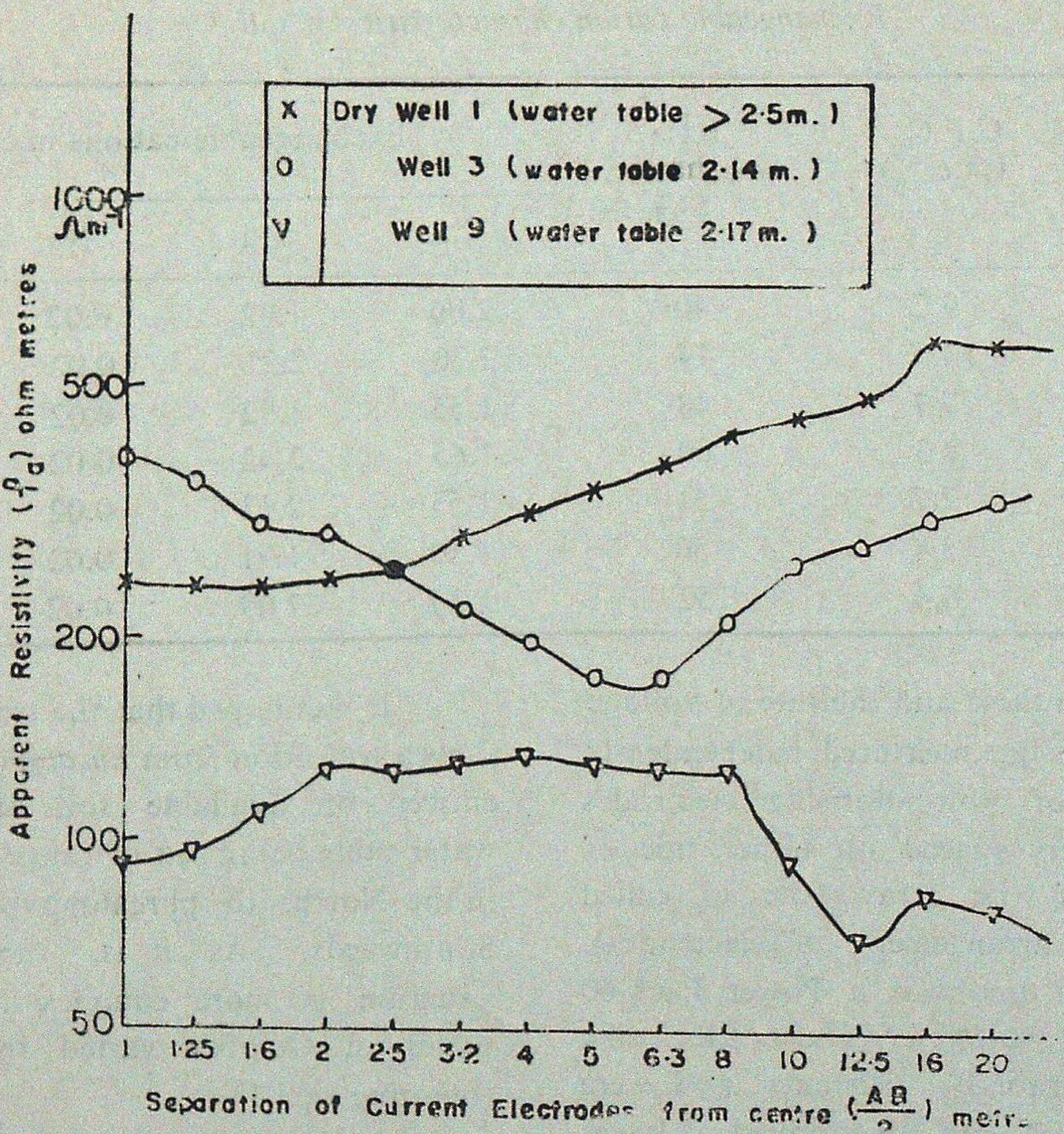
Results

The disposition of water-table levels : In the sandy loam soils of the Northern end of the transcet, apart from the dry well (No. 1), the water-table was 1.4-2.1 m deep. The brown silty loams of wells 6 to 10 exhibited deeper water-tables (2.1 m to 2.6 m) perhaps being on a steeper interfluve with the streams somewhat incised.

It was hoped that the transect would show a transition from *Eucalyptus* dependent entirely on available soil moisture (the water-table being out of range of the roots) in the North, to phreatophytic *Eucalyptus* Southwards. As it is, the hydrologic situation is more complex and the water-tables in October varied by 1.2 m only (ignoring well 1).

Earth resistivity : Well 1 was dry and could not easily be deepended, so it was necessary to try to locate the water-table by using this electrical method. The apparent resistivity (ρa) is calculated in terms of ohms/metre by the expression $\rho a = \frac{\pi}{MN} \left[\left(\frac{AB}{2}\right)^2 - \left(\frac{MN}{2}\right)^2\right] \frac{\Delta V_{MN}}{I_{AB}}$ where AB is the separation (metres) of the outer (current) electrodes carrying a current of I_{AB} (mA); MN (metres) is the separation of the non-polarising electrodes which show a measured potential difference of ΔV_{MN} millivolts. The results for three transect position are shown in Figure 1 on log/log

Fig. 1



Earth resistivity measurements with electrode separation in the vicinity of water-table.

plot against the distance of the current electrodes from the centre of the array (i.e. $\frac{AB}{2}$ metres).

The finer textured soil (well 9) had lower resistivities ($\leqslant 135\Omega m^{-1}$). The stoney layer at the bottom of the dry well (No. 1) reached the highest value measured ($613\Omega m^{-1}$). There is nothing to indicate that the water-table had been approached in the resistivity measurements at this site: greater separation of the current electrodes should have been employed. In the top of this profile the slight fall in resistivity was probably due to a moisture horizon which was associated with mottled soil colours and suggested a transient or perched water-table after rains. This might be useful source of water for the trees (Fig. 1).

Even the simplest of the curves (well 1) could not be matched to standard curves for two layered systems (White, 1985), which indicates that resistivity/depth soundings for these soils are rather complex. The lack of any clear correlation of the resistivity measurements with the water-table depth may be because so early in the dry

season (28/29 Oct.) there is insufficient distinction between the resistivity due to the water-table and that of the moist soil above. When the observations are repeated next May, it will be sensible to have the log, steps in electrode separation at least for $\frac{AB}{2} \leq 3$ metres.

Seasonal water-tables : It should be noted that the transect passed within 350 m of small forest settlement with some irrigated plots to the West (nearest points 2 and 3) and some irrigated fields 150 m to the East and nearest point 7. These developments undoubtedly cause a lowering of the water-table, but we believe the transect would be affected to an insignificant extent. The effect in any case would be to magnify the seasonal fluctuation.

In the begining of the wet season (29 June) the water in the large well at location 4 stood at 1.7 m. At the end of the monsoon (28 Oct.) it had risen to 1.4 m. The relatively small change reflects the supply of water percolating laterally through the soil from the Bhabar in the North. This almost completely compensates for abstraction by phreatophytic vegetation in the Tarai and the springs feeding the perennial streams which rise in Horai Block. The figures may be compared with the reported well levels in Table 1 which we may suppose are more likely to be affected by abstraction for domestic use, but which confirm an annual fluctuation of less than one metre, and in general terms, at the maximum depths may be expected prior to the monsoon and the minimum depths from the mid-monsoon onwards.

Diurnal fluctuations of water-table : A water stage level recorder on the wide well (No. 4) showed an almost regular rise in level of 0.4 mm/hr when the height may be supposed to be nearing its maximum towards the end of October. However, from perhaps 1000 hr to 1530 hr on 23 Oct. there was actually a fall in water level, a fraction of a centimetre. Even on 24 Oct. there was minimal rate of rise at 14.30 The same well in June (when the water level was only 27 cm deeper) showed evidence, but not very conclusively, that the level fell 2.5 cm in daylight hours. The adjacent but narrow well No. 5 on a similar site, again about 20 m from a small stream, also exhibited overall a tiny rise (less than 5 mm in 24 hr. on 26 and 27 Oct) The level was at a maximum in the early hours of the morning, but had begun to fall by 0830 hr. By 1800 hr it fell to the deepest (as much as 10 mm below the predawn level). The information extracted from the recorder charts is summarised in Table 2. The somewhat greater sensitivity of well 5 is consistent with Diebold's (1954) recommendations for digging inspection wells : that ideally they should be as narrow as feasible to have a small capacity and respond rapidly to the rise and fall of the water-table in the adjacent soil.

The diurnal fluctuations in wells 4 and 5 are in phase with the expected course of transpiration through the day and could be caused by the local absorption of water by tree roots. Such a phenomenon is well known and extends to a diurnal fluctuation of stream levels until adjacent phreatophytic vegetation is removed. It would be interesting to remove trees successively in concentric zones outwards from one of these wells to see what clearing

is necessary to prevent the fluctuations.

Data from three wells, 2, 3 and 7, with slightly deeper water-tables, indicate that the maximum rate of rise took place in the late afternoon or early evening, whereas the maximum rate of fall of the water-table (or the least rapid rise in well 7) was after midnight. The water level was, therefore, at its shallowest early in the night and deepest in the forenoon. This needs confirmation, but it seems that this fluctuation is out of phase with direct abstraction, perhaps because of transmission through a capillary zone above the water-table.

The fluctuations shown on the charts of the water stage level recorder are so small that the manual measurement of wells (say at 0900, 1300 and 1800 hr) was insufficiently sensitive to detect them.

Discussion and Conclusion

If the location of our observations is at all typical of the Southern Tarai, then it is evident that taprooted *Eucalyptus* hybrid trees would have little difficulty in reaching the water-table over much of the area. The Northern part may have little or no phreatophytic *Eucalyptus*. The limited annual fluctuation of the water-table suggests that the relation of the roots to the water-table would not be seasonal. Roots could easily grow downwards with the falling water-table even if they were unable to survive beneath it when it was shallow.

The diurnal fluctuations of the water-table at 1.5 m depth in S. England in a stand of *Carpinus betula* could exceed 3 cm in summer (Reynolds, unpublished) which would easily be measured by taking two readings of depth during the day. There could be several explanations of the contrast with the Tarai records. (i) the wells in England were less than half the cross-sectional area and were therefore more sensitive, (ii) the saturated conductivity of the Tarai soils may be very high, (iii) a large hydrologic head may exist in a very extensive Tarai hydrologic systems, (iv) the *Eucalyptus* in October may be using the recharged soil moisture storage in preference to phreatic water, or (v) the direct abstraction by the *Eucalyptus* from the water-table may be negligible at the stations examined. Clearly, another brief visit to the location next May should clearifyp oint (iv). On such a visit pumping tests on the wells would throw light on (iii), although crude measures of the rise of level in wells 2, 3 and 6 within 7 hr of boring them suggested that the rate of ingress was of the order of 0.13 to 3.35 cm hr^{-1} through the wall area of the well below the water-table, depending on the hydraulic head. Examination of some shallower water-tables nearer the streams would illuminate point (v) and some narrow wells point (i). In the meantime the most tenable hypothesis might be that the taproot of *Eucalyptus* (where it exists) is not a major absorber of water from the water-table. Where the superficial root system is in contact with the capillary fringe of water-tables rather shallower than 1.5 m, direct absorption could be significant.

Acknowledgement

The authors are thankful to Shri M.S. Bisht, R.A. II, Forest Influence Branch for the assistance during the course of investigations. They are also thankful to the Divisional Forest Officer, Tarai East Forest Division, Haldwani for providing the facilities during the field studies and Director Crop Research Centre, Pantnagar for providing Met. data.

SUMMARY

Hydrologically it is important to distinguish phreatophytic vegetation, as the access to the water-table enables plants to transpire the full potential and not conserve water. However, there is much misunderstanding outside the hydrological discipline on the location and behaviour of the water-table. We describe the mathods of wells and electrical resistivity which we have employed in a Terai *Eucalyptus* plantation to study the water-table, and we discuss the preliminary results which as yet demonstrate little direct abstraction by the trees from water-table deeper than 1.5 metres.

प्रतिरोधिता रीति द्वारा संकर यूकेलिप्टस लगाने पर जल-स्तर का अन्वेषण

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सारांश

जल विज्ञान की दृष्टि से कूप पादपीय वनस्पतियों को पहचान कर लेना महत्वपूर्ण बात है क्योंकि जल स्तर तक पहुंच होने पर पादप कुल सम्भव जल श्वसन द्वारा निकाल देते हैं; उसे सरक्षित करके नहीं रखते, किन्तु जलविज्ञान अनुशासन से बाहर जल-स्तर की स्थिति और व्यवहार के सबन्ध में बहुत मिथ्या धारणाएं फैली हुई हैं। यहां हमने कुओं और विद्युत प्रतिरोधिता विधयों का वर्णन दिया है जिन्हें हमने जल-स्तर के अध्ययन के लिये तराई स्थित यूकेलिप्टस रोपवन में उपयोग किया। हम अपने प्रारम्भिक परिणामों का विवेचन कर रहे हैं जिनसे अभी तक ऐसी कोई प्रत्यक्ष धारणा नहीं बन पाती कि इसके वृक्ष 1.5 मी से० अधिक गहरे जल-स्तर से पानी ग्रहण करते हैं।

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ROLE OF FUNGI IN WEATHERING OF TEAK FRUITS

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Introduction

Teak fruits are subjected to a process of weathering before use in nursery. Banerjee (1942) devised a method for weathering of teak fruits for early germination. During the process of weathering several micro-organisms including fungi play an important role for the degradation of epicarp which is made up of cellulose. The microbial activity also loosens the mesocarp (hard nut) aiding in early germination of seeds. In the present study the role of some fungi on weathering of teak fruits has been studied.

Fresh fruits of teak were collected during March-April from Mandla Division, M.P. The fungal flora associated with the fruit and seed were recorded by adopting the procedure recommended by International Seed Testing Association (1966). Some other common methods were also used for routine testing of seeds as reported by Jamaluddin and Neelay (1980). The percentage frequency of fungal flora were recorded by taking 400 fruits. The results are presented in Table 1.

During litter decomposition in teak plantation, *Trichoderma harzianum* and *Scytalidium* sp. were recorded as the major cellulolytic fungi (Soni, 1985). Both these fungi were used for removal of epicarp of teak fruits. The experiment was conducted in two litre flasks as well as in wooden trays (100×50×15 cm) in triplicate. The fruits were fumigated with formaldehyde in order to remove surface microbial contaminants of teak fruits. Freshly prepared spore suspension of *Trichoderma harzianum* and *Scytalidium* sp. prepared separately, were added in moist teak fruits in the flasks and in wooden trays. The fruits were kept moist and undisturbed for three days. Later on the fruits in flask and trays were shaken for uniform growth of the inoculated fungi twice in a day. The fruits were always kept moist. After 21 days it was observed that the epicarp of teak fruit became soft in the

Table 1

The occurrence of fungi on teak fruit

Name of fungi	Percentage occurrence
Phomopsis tectonae Tiwari, Rajak & Nikhara	3
Alternaria alternata (Fr.) Keissler	4
Chaetomium globosum Kunze ex. Fr.	40
Stachybotris atra Corda	15
Aspergillus flavus Link	36
Aspergillus niger Van Tiegh.	21
Penicillium parvum Raper and Fennell	12
Fusarium oxysporum Schlicht	6
Cephalosporium acremonium Corda	10
Graphium bulbicola Hennings	9
Rhizopus nigricans Ehrenberg	10
Curvularia pallescens Boedijn	3
Trichoderma harzianum Rifai	10

fruits can fruit lot treated with *Scytalidium* sp. The epicarp was easily removed by frequent turning while the fruits treated with *T. harzianum* do not show complete decopmosition of epicarp. They were similar to untreated fruits. The appearance of basidiomycetous fungi like *Coprinus* sp. and *Inocybe* sp. was more in the untreated lot and the lot treated with *T. harzianum* but the appearance of such form was less in the fruits treated with *Scytalidium* sp. because of its high cellulolytic activity.

In Belkund Teak Nursery, Kundam Project, Jabalpur heavy attack of *Coprinus* sp. and *Inocybe* sp. were also noticed in nursery beds, which suppressed the germination of teak seeds in the nursery.

The fungal flora of treated and untreated fruits were recorded after 21 days and presented in Table 2. The seeds were extracted from the weathered fruits treated with *T. harzianum*, *Scytalidium* sp. and control (untreated) after 21 days and kept in moist filter paper in Petriplates at 30°C. The germination percentage and fungi associated with the seeds were also recorded in Table 2.

Table 2 revealed that there were less number of fungi associated with the fruits treated with *Scytalidium* sp. as well as the germination of seeds extracted after weathering was more as compared to fruits treated with *T harzianum* and untreated (control). Such weathring of fruits through use of *Scytalidium* sp. is practically possible and can be recommended for early weathering of teak fruits. This shortens the period of weathering of teak fruits and the weathered

Table 2

Effect of Trichoderma harzianum and Scytalidium sp. on weathering of teak seeds

Treatment	No. of fruit used	Fungal flora associated with weathered fruits.	No. of seed germinated	Fungal flora associated with extracted seeds
Untreated fruits	400	*Graphium bulbicola*, *Chaetomium globosum*, *Ciliochorella* sp., *Phoma* sp., *Alternaria alternata*, *Coprinus* sp. & *Inocybe* sp.	20	*Fusarium* sp.
Fruits treated with *T. harzianum*	400	*Coprinus* sp., *Inocybe* sp. *C. globosum*, *T. harzianum*, *Graphium bulbicola*	Nil	*Fusarium* sp.
Fruits treated with *Scytalidium* sp.	400	*Graphium bulbicola*, *Scytalidium* sp.	96	*Fusarium* sp. & *Rhizopus* sp.

be utilized in nursery during the same season. Whereas in current nursery practices the complete weathering takes a long time and the fruits are not utilized in the same year of collection. This process of fungal weathering hasten the epicarp decomposition. The fruits after removal of epicarp can be sown in the nursery beds which take about 21 days for initiation of germination in beds.

SUMMARY

A wide variety of fungal flora is involved during the process of natural weathering of teak fruit, *Scytalidium* sp. exhibited fast decomposition of epicarp from the fruit which resulted the completion of weathering of teak fruits within 21 days. The seeds extracted from such weathered lot through use of *Scytalidium* sp. exhibited high percentage of germination as compared with the other treatments. It is recommended that *Scytalidium* sp. can be used for fast weathering of teak fruits.

सागोन फलो के ऋतुप्रभावन में कवको की भूमिका

वी०एस० डडवाल व जमालुद्दीन

सारांश

सागोन के फलों के प्राकृतिक ऋतुप्रभावित होने की प्रक्रिया मे बहुत सारे तरह-तरह के कवकों का योग रहता है। स्काइटैलिडियम प्रजा० ने इसके फल के बाहरी छिलके को तेजी से विघटित करने मे भाग लिया जिनसे सागोन के फल का ऋतुप्रभावन 21 दिन में ही पूरा हो गया। इस तरह स्काइटैलिडियम से ऋतुप्रभावित फलों से लिए गए बीजों के अकुरण का प्रतिशत अन्य उपचार किए बीजों की तुलना में अधिक रहा। हमारा अभिस्ताव है कि सागोन फलों को तेजी से ऋतुप्रभावित करने के लिए स्काइटैलिडियम प्रजा० का उपयोग किया जा सकता है।

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ROOTING STUDIES OF *PUNICA GRANATUM* AND *DALBERGIA SISSOO* CUTTINGS UNDER CONTROLLED PHYTO-ENVIRONMENT CONDITIONS

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Introduction

Much emphasis is being laid on the artificial regeneration of tree species for social and agro-forestry programmes these days. A multiplication by vegetative means offers the advantage of greater genetic uniformity and immediate availability of superior clones for plantation work. Plants with desired characters as high fruit/seed yield, resistance to diseases and pests, good branching and stem form, fast rate of growth and quality production can be multiplied at will and made available in the shortest possible time. Nursery raising through seeds, on the other hand, can not fully meet the increasing demand and take a long time for eventual planting out in the field.

With the increasing demand on tree improvement and for optimising biomass production, the importance of vegetative propagation has increased. The rooting success of stem cuttings depends upon proper environmental treatment. Brix and Barker (1975) and Puri and Shamet (1986) have stressed the importance of environment particularly that of high humidity for proper rooting of cuttings. The potential for increased genetic gain through vegetative propagation of forest tree has been demonstrated by many workers (Libbey, 1974; Brix and Van den Driessche, 1977; Khosla *et al.*, 1982). In the present investigation attempt was to study the rooting behaviour of two important farm forestry tree species *Punica granatum* and *Dalbergia sissoo* under the controlled phyto-environment system.

Methodology

Stem cuttings (25 cm) of *Punica granatum* and *Dalbergia sissoo* were made from one-year old branches of plants (10-12 years old) growing in the forests near University of Horticulture and Forestry, Solan after excising the apical part and the leaves. These were divided into 12 groups with 10 cuttings in each group. Group 1 was treated with distilled water to serve as control. Groups 2-9 were treated with 5,000-, 10,000-, 15,000- and 20,000 mg/l each of IAA and IBA and groups 10-12 were treated with 2,000-, 5,000- and 10,000 mg/l of NAA. The chemical treatment was given as a quick dip (2-3 sec.) method during August, 1986. The cuttings were then transferred in polythene bags (5 × 10 cm) filled with river sand and kept in the mist chamber unit. Misting

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is done at regular intervals i.e., misting is 'on' for 10 seconds and 'off' for 10 minutes. The air temperature was maintained at 20-25°C with slightly higher temperature of the rooting beds (23-27°C). Relative humidity was maintained at 85-95%. The experiment was kept under observations till 45 days. The rooted stocks were then taken out, washed thoroughly and observations were taken on rooting per cent, average root number and average root length for both the species.

Results

Punica grantum : The roots were produced in all the cuttings regardless of whether these were treated with water, IAA, IBA or NAA (Table 1). However, rooting percentage was much higher in IBA-, IAA- and 2,000 mg/l NAA-treated cuttings as compared with control. Higher concentrations of NAA suppressed root formation in the cuttings.

Similarly, average root number was much higher in 15,000 and 20,000 mg/l IAA-, 5,000 and 10,000 mg/l IBA and 2,000 mg/l NAA-treated cuttings. All other treatments had suppressive effect on the number of roots. Average root number was significantly higher in cuttings treated with 10,000 mg/l.

The average root length was observed to be maximum in cuttings treated with higher concentration (20,000 mg/l) of IAA and 10,000 mg/l IBA.

Dalbergia sissoo : All the chemical treatments promoted adventitious root formation as compared with control (Table 1). However, rooting percentage was much higher in cuttings treated with 2,000 mg/l NAA, 5,000 mg/l IBA and 10,000 mg/l of IAA. 2,000 mg/l NAA resulted in 70 per cent rooting in the cuttings.

Similarly, average root number was higher in cuttings treated with hormones. The average root number was significantly higher in cuttings treated with 2,000 mg/l NAA.

The hormonal treatment did not much affect the average root length except for 2,000 mg/l NAA and 5,000 mg/l IBA which increased the average length of roots significantly as compared with control.

Discussion

Both *P. granatum* and *D. sissoo* are hard to root species. Exogenous application of auxins like IAA, IBA and NAA enhanced root formation upto 55 per cent in *P. grantum* and 70 per cent in *D. sissoo* when used as quick dip method under controlled conditions. Ye (1984) observed 85.7-91.3 per cent rooting in *Dalbergia sissoo* cuttings treated with 100-200 ppm of IBA and NAA. Negi (1982) reported that 100 ppm IAA, IBA and NAA increased number of rooted cuttings and per cent rooting in *D. latifolia*. That exogenous application of auxins enhance rooting in hardwood cuttings has been reported by many workers (Nanda, 1970; Puri and Shamet, 1986). Haissig (1972, 1979) has shown that the division of first root initial cell is dependent upon either exogenous or indigenous auxins. Auxin treatment and rooting under mist (Long *et al.*, 1956) cause considerable cell expansion and proliferation in the cortex, phloem and cambium resulting in breaks in continuous sclerenchymatous rings. It is now well established that the rooting response of cuttings is controlled by a balance

Table 1

Effect of some growth regulators on rooting behaviour of P. granatum and D. sissoo under controlled phyto-environment conditions.

Treatment (mg/1)	*P. granatum*			*D. sissoo*		
	Rooting (%)	Average root number	Average root length (cm)	Rooting (%)	Average root number	Average root length (cm)
Control	15	7.2 * 1.25	4.5 * 1.15	5	2.0 * 0.40	2.3 * 0.23
IAA, 5,000	25	6.8 * 1.48	7.0 * 2.29	40	9.0 * 1.19	6.7 * 0.91
IAA, 10,000	20	4.6 * 1.71	5.3 * 1.09	45	14.8 * 4 85	7.4 * 0 79
IAA, 15,000	40	15.6 * 5.75	9.8 * 0.67	35	11.4 * 2.29	4.6 * 0.86
IAA, 20,000	55	15.2 * 4.23	10.0 * 2.80	30	11.2 * 2.39	4.0 * 0.55
IBA, 5,000	50	16 8 * 3.13	6.4 * 1.44	65	20.0 * 3.90	8.0 * 0.77
IBA, 10,000	55	22 8 * 3.24	10.7 * 1.99	35	11.6 * 2.22	4.4 * 0.86
IBA, 15,000	40	10.0 * 2.58	7.2 * 1.64	20	10.4 * 3 01	4.8 * 0.19
IBA, 20,000	40	12 0 * 2.50	9.1 * 0.88	20	6.6 * 1.19	3.8 * 0.64
NAA, 2,000	25	9.8 * 1.53	6.7 * 1.68	70	23.0 * 3.36	9.0 * 0.51
NAA, 5,000	10	3.6 * 0.73	5.4 * 1.07	45	14.2 * 4.26	4.3 * 0.54
NAA, 10,000	10	2.7 * 0.50	2.2 * 0.50	15	4.1 * 0.52	3.9 * 0.43

* denotes Standard error ±

between nutrition and auxin (Nanda, 1970; Nanda and Dhaliwal, 1974). It may also be noted that the auxins also improve the quality of root system (root number and root length).

SUMMARY

Exogenous application of auxins promoted root formation in cuttings taken from one-year old branches of *Punica granatum* **and** *Dalbergia sissoo* **under controlled conditions. All the concentrations of IBA, 10,000 and 15,000 mg/1 of IAA and 2,000 mg/1 of NAA were most effective when applied as quick dip method. Auxins not only enhanced root formation but also increased the number of roots per cutting and average root length.**

नियंत्रित पादप-पर्यावरण दशाओं में प्यूनिका ग्रेनेटम और डलबर्गिया सिस्सु की कलमों में जड़ें निकलने का अध्ययन

जी०एस० शामेट व एस० कुमार

सारांश

बाहर से ऑक्सिन देने से प्यूनिका ग्रेनेटम और डलबर्गिया सिस्सु की एक वर्षीय शाखाओं की कलमों को नियंत्रित दशाओं में लगाने पर उनमें जड़ें निकालना प्रोत्साहित हुआ। इन्डोल ब्यूटरिक अम्ल के सभी

सकेन्द्रण, इण्डोल एसेटिक अम्म के 10,000 व 15,000 मिली ग्रा०/1 तथा नाइट्रिक एसेटिक अम्ल का 2,000 मिली ग्रा०/1 सकेन्द्रण डुबाने की रीति द्वारा उपयोग करने पर सबसे अधिक प्रभावकारी रहे। ऑक्सिनों से जड़ें बनाना ही बढ़ा उससे प्रति कलम जड़ों की संख्या और जड़ों की औसत लम्बाई में भी वृद्धि हुई।

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STUDY OF SOME AGRONOMIC ASPECTS OF SABAI GRASS (*EULALIOPSIS BINATA* RETZ.)

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Introduction

Sabai grass (*Eulaliopsis binata* Retz.) is the most important of the numerous grasses and is one of the major raw materials for paper industry in the country since 1870 (Bhat *et al.*, 1960; Mukherjea and Sharma, 1967). It is also twisted into ropes.

Sabai grass is a perennial, caespitose grass, culms 60-90 cm tall, erect, slender, 3-4 noded, somewhat compressed, channelled along one side, very glabrous, sending out flower-bearing branches at the upper 2 or 3 nodes, often solitary; leaf blades are broad and hardly distinct from the sheath, almost erect (Bor, 1940).

Although Sabai grass has been used for more than a century for different purposes, no systematic work regarding its improvement and/or domestication has been carried out. The preliminary investigations were, therefore, undertaken with the object of evaluating different genotypes under varying row-spacings and cutting management, thereby, exploring the feasibility of its domestication.

Material and Methods

Field investigations were carried out during 1984 and 1985 at Punjab Agricultural University, Ludhiana. Two row spacings (S_1=30 cm, S_2=60 cm); twelve genotypes and two cuttings (C_1=Summer cutting during end June and C_2=winter cutting during end December) were allotted to main, sub and sub-sub plots, respectively in a double split-plot design with three replications. Plant to plant spacing was 30 cm. The root slips were transplanted on the sandy soil which was low in N, medium in P and high in K. Soil pH was about 8.2. Forty kg N/ha was applied in three splits. Data were recorded on green and dry matter yields on plot-basis while plant height was noted on randomly selected plants.

Results and Discussion

Wider row spacing (60 cm) increased both green and dry matter yields significantly over narrow spacing of 30 cm (Table 1). This increase was about 73 per cent for green as well as dry matter yields. Wider row spacing also produced 15 per cent taller plants than in narrow spacing. Similar results showing the superiority of wider spacing have been reported by many workers in other grasses and crops (Watson and French, 1961; Gupta *et al.*, 1970; Mazurek and Mazurek, 1970; Umrani *et al*, 1974; Ben-Herut and Abu-Alrub, 1980). Parshina (1978) observed maximum chlorophyll content and photosynthetic activity in wheat leaves when grown under

Table 1

Effect of row spacing and time of cutting on growth and yield of Sabai grass

Characters	Green matter (q/ha)			Dry matter (q/ha)			Plant height (cm)		
Row spacing	C_1	C_2	Mean	C_1	C_2	Mean	C_1	C_2	Mean
(S_1) 30 cm	54.72	50.73	52.72	32.29	27.04	29.67	86.1	70.6	78.4
(S.)	107.10	75.46	91.28	60.89	41.98	51.44	102.5	79.0	90.7
Mean	80.90	63.10		50.93	42.92		94.3	74.9	
C.D. at 5%	Spacing=3.31				6.47		3.93		
	Cutting=8.20				15.85		9.62		
	Spacing× Cutting=4.68				9.15		5.56		

wider row spacings. Moreover, photosynthetic active radiation interception has also been reported to increase with an increase in height and spread of the plan s with age (Dhingra *et al.*, 1986). Thus, these two studies provided a physiological basis of increase in green and dry matter yields in Sabai grass under wider row spacing.

The genotypes differed significantly with respect to green and dry matter yields (Table 2). PBG-58 recorded highest green (89.58 q/ha) and dry (54.05 q/ha) matter yields, which were closely followed by PBG-13 and PBG-36. These genotypes were found to be taller, which resulted in higher biomass production.

Summer and winter cuttings were significantly different for green and dry matter yields (Table 1). Summer cutting recorded a superiority of 28.0 and 18.7 per cent green and dry matter yields, respectively, over winter cutting. High temperature, humidity and light intensity might have crea ed favourable conditions for better function of plant system thereby increasing the yields. Similar findings were reported by Pohjakallio (1952), Wattal and Asana (1974) and Kler *et al.* (1984).

The genotype-spacing interaction was found to be significant (Table 2). Most of the genotypes gave better performance under wider row spacing. The spacing-cutting interaction was also found to be significant (Table 1), indicating thereby that wider row spacing during summer gave better performance.

These studies revealed that genotypes of Sabai grass need further evaluation for different agronomic aspects in order to explore the feasibility of its domestication.

Table 2

Effect of row spacing and genotypes on different traits of Sabai grass.

Genotype	Green matter (q/ha)			Dry matter (q/ha)			Plant Height (cm)		
	S_1	S_2	Mean	S_1	S_2	Mean	S_1	S_2	Mean
PBG-13	69.68	106.94	88.31	37.73	58.80	48.27	85.2	100.3	92.8
PBG 20	46.99	92.13	69.56	29.63	55.09	42.36	78.5	82 5	80.5
PBG 22	34.95	60.18	47.57	21.30	32.37	26.83	76.5	85.2	80.8
PBG 23	57 87	58.80	58.33	31.25	34.26	32.76	67.8	81.3	74.8
PBG 27	61.81	93.98	77.89	34.95	55.09	45.02	82.3	89.0	85.7
PBG-29	50.00	122.69	86.34	27.78	66.67	47.22	70.0	93.0	81.5
PBG 33	39.82	104.63	72·22	22.92	55.37	39.14	77 5	81.8	79.7
PBG 34	56.95	49.54	53.24	32.18	25.23	28.70	86.0	90.7	88.3
PBG-36	68.98	103.71	86.34	36.58	58.80	47 69	74.5	91 8	83.2
PBG-43	32.87	68.98	50.93	17.83	37.50	27.66	78.7	102 8	90.8
PBG-48	64.12	103.24	83 68	34 95	58.89	46.92	84.7	89.3	87.0
PBG 58	48.61	130.56	89.58	28.94	79.16	54.05	78.8	100.5	89.7
	52.72	91.28		29.67	51.44		78.4	90.7	
C.D. at 5%	Spacings=6.47			39.3			3.31		
	Genotypes=15.58			9.62			8.11		
	Spacing × Genotype=22.42			13.61			N.S.		

SUMMARY

Field investigations conducted on some agronomic aspects of Sabai grass at Punjab Agricultural University, Ludhiana revealed that wider row spacing (60 cm) increased both green and dry matter yields significantly over narrow spacing (30 cm). Out of twelve genotypes of Sabai grass studied, three genotypes viz., PBG-58, PBG-13 and PBG-36 were found to be high yielding and seem to be suitable for cultivation. The genotype-spacing and spacing-cutting interaction was significant.

सबई घास (इयूलालियोप्सिस बाइनेटा रेजि०) के कतिपय सस्यवैज्ञानिक
पक्षों का अध्ययन

एस०आर० शर्मा, ए०एस० खेड़ा व बी०एस० भुल्लड़

सारांश

सबई घास के कतिपय सस्यवैज्ञानिक पक्षों पर पंजाब कृषि विश्वविद्यालय लुधियाना में किये क्षेत्र अन्वेषणों से पता चला है कि इसकी पंक्तियों में अधिक दूरी रखने (60 सेमी०) से इसके हरे और शुष्क पदार्थ

उत्पादन में कम फासला देने (30 सेम०) मुकाबले मे सार्थक अधिक प्राप्ति मिलती है । सबई घास के अधीत बारह समपित्रैंको में तीन पित्रैंक अर्थात पीबीजी–58, पीबीजी–13 और पीबीजी-36 अधिक उत्पादन देने वाले निकले और कृषि कार्य के लिए उपयुक्त लगते हैं । समपित्रैंक फासला देना और फासला-कटाई त्रिया प्रतिक्रिया साथक प्रतीत होते हैं ।

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FIELD STUDIES ON THE INITIAL MORTALITY OF LAC INSECT *KERRIA LACCA* KERR. IN RELATION TO HOST PLANTS

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Introduction

Lac is a resinous secretion of a very minute lac insect, is one of the versatile resin of animal origin. The lac insect has a delicate body, posteriorly pointed ovate measuring 0.6 mm long and 0 25 mm width having different colours. The crawler emerge in large number at the time of crop maturity from the mother cells and varies in number according to the crops. As soon as the emergence of larvae start they crawl over the twigs of the host plants in search of adequate site to settle for their food as per nature of the insects. An average female produces 130-400 larvae which settle gregariously. The emergence of larvae from mother cell continues for a fortnight to three weeks depending upon the climatic conditions. The larvae puncture the skin of the twigs and insert their proboscis up to phloem to suck the plant juice for the survival. Once settled, they do not change site till maturity. Like other species where natural mortality is associated with predation in immature stage (Valiela, 1969; Thomas *et al.*, 1983) it also occurs in lac insects but after the third week of inoculation.

This study was conducted with the objective to assess the quantity of initial mortality in crawling stage of lac larvae in rangeeni strain in relation to major hosts i.e. Palas (*Butea monosperma* Lam., Taub.), Ber (*Ziziphus mauritiana* Lam., and Bhalia (*Moghania macrophylla* Willd.) O. Ktze. of economical importance. The rangeeni strain has two crops in a year of unequal duration of maturity. Though this strain is considered inferior but contributes more than 80 per cent of total lac production of the country.

Material and Method

The expriment was conducted on 4 plants of 3 lac host species, namely : Palas, Ber and Bhalia. Uniform mature homozygous female cells were chosen. The 4 branches of each tree were selected for inoculation in both crops. Baisakhi and katki of rangeeni strains. The female cells covered with a synthetic net of 60 mesh and tied over the twigs. Special attention was paid so that no crawler emerged before inoculation and they were left in natural out door condition. The initial mortality was evaluated in different month of the year in different crops. For scoring initial mortality in katki crop the inoculation with single female cell was done in June whereas for baisakhi crop it was done in October. The cells which were used in inoculation were left on twigs for one month to ensure the complete emergence of lac larvae from the mother cells. Mortality observations were not extended

to include survival upto adult stage. To determine the mortality of lac larvae a complete sampling design was followed by four treatment and with four replication. Before the completion of three week it was observed that larvae emerging from mother cell crawl in search of suitable surface on twig for the nourishment. The larvae which come first get enough time, place and choice where to sit. Gradually the late comers have lesser chances to adjust themselves. Meanwhile they are crawling over the twigs, as there is no chance of overlapping in settlement they are crawling continuously in search of food which they get from plant juices after the insertion of proboscis. The ultimate result comes into mortality due to starvation. All the twigs from all treatment and replication of different host trees were cut after a month of inoculation and brought to laboratory to score the initial mortality. The larvae which settled but died due to the environmental factors and starvation can easily be distinguished by their black and pale colour and it is easier to wash the starved larvae by brush from the twigs in comparison to the larvae died after settlement This study was conducted in both crops i.e. baisakhi and katki of each year during 1984 to 1986.

Result and Discussion

Palas is a medium sized deciduous tree having somewhat crooked trunk attaining a height about 2-3 metre and a metre girth belonging to family Leguminoceae. Ber is also a moderate sized deciduous tree having short bole spreading rounded crown and drooping branches armed with stipular spines belong to family Rhamnaceae with tall girth of a metre. Bhalia is a perennial shrub and grows about 2.5 metre in height belonging to family Leguminoceae.

Larval survival on the three host plants is intercomparable (Table 1). It is clear that mortality after the settlement is higher in many crop seasons in comparison with the death rate due to starvation. It is known that the fecundity of a single mother cell varies from 130-400 nymphs. Most of the larvae which emerge early have got enough chance to settle, the larvae emerging late and is lasser in number. But in crop like katki '86 season starved mortality was found higher in Ber and Palas.

It is evident that Palas shows always highest mortality in both crop followed by Ber and Bhalia vice-versa which shows the plant effects. Although the lac larvae did suffer higher mortality on different host plants but because of its population density they survive upto crop maturity. The other factor is response of the twigs of different host plants in settling behaviour of the larvae as the shoots are smooth and rough pubescent hairy in their nature. In rangeeni strain, the settlement of larvae is not patchy as Kusum but coverage is not all over the surface of twigs. The hosts Palas, Ber and Bhalia having different nature in their response to settlement behaviour in relation to the plant effects. The branches of Palas are rough more hairy in comparison to Ber and Bhalia whereas Ber has spiny branches and less hairy than Palas and Bhalia.

Thus the variation in initial mortality differ in crawling stage of lac insects as per nature of shoot of different host plants as reflected by the survival as well as inter-specific competition triggered by settlement behaviour of lac larvae occupying the twigs of different host plants.

Table 1

Percentage of mortality

Host		Baisakhi 1984-85		Katki 1985		Baisakhi 1985-86		Katki 1986	
		Starved (%)	Dead (%)	Starved (%)	Dead (%)	Starved (%)	Dead (%)	Starved (%)	Dead (%)
Palas	1	17 66	33.95	12.36	28.81	11.09	37.11	11.16	26.15
	2	19.29	36.84	15.37	33.12	12.57	37.75	17.03	21.58
	3	28.00	41.91	20.02	32.94	13.47	32.81	18.19	28.21
	4	15.16	47.45	14.99	33.81	22.87	30.20	15.13	20.39
Mean		20.17	40.03	15.68	32.17	14.98	34.46	17.12	24.08
Total		60.20		47.85		49.44		41.20	
Ber	1	14.31	29.10	07.36	34.56	11.47	33.77	20.05	12.75
	2	07.49	18.03	08.00	32.20	12.32	38.08	17.57	12.83
	3	08.68	22.71	11.01	29.11	13.95	33.18	23.20	09.05
	4	09.99	16.87	07.69	27.05	13.49	39.16	17.71	08.84
Mean		10.11	21 67	0.86	30 37	12.80	36.04	19.63	10.86
Total		31.78		39.24		48 84		30.49	
Bhalia	1	12.19	39.53	12.90	37.89	12.90	35 58	13.16	12.27
	2	14.55	38.15	09.36	34.08	13 03	34.63	15.47	13.98
	3	16.74	29.65	16.91	32.68	11.61	35.84	16.87	16.68
	4	22.30	38.84	10.23	35 39	12.75	34.42	19.98	10.22
Mean		16.44	36.54	12.35	35.01	12.57	35.11	16.37	13.28
Total		52.98		47.36		47.68		29.65	

Acknowledgement

The author is thankful to Dr. B.B. Khanna, Ex-officiating Director and to Head of Division of Entomology of the Institute for providing facilities and also to Shri D.K. Singh and Shri R.K. Swansi for their technical help.

SUMMARY

Mortality during crawler stage of Indian lac insect was studied over three years on six lac crops of rangeeni strain in Institute plantation on three different lac hosts. The average mortality percentage was 41.20 to 60.20 on Palas; 30.49 to 48.84 on Ber and 29.65 to 52 98 on Bhalia. The probable causes are not only the climatic factors but also the nature of the twigs for the settlement suitability and struggle between to have wider scope for existance in crawling stage with the ultimate result of mortality due to unavailability of proper place to get nourishment for continuing the race.

पोषी पादपों के सम्बन्ध में लाख के कीड़े केरिया लाक्का केर० की प्रारम्भिक मरणशीलता का क्षेत्रीय अध्ययन

एम०एल० भगत

सारॉश

रेंगने की अवस्था में भारतीय लाख के कीड़े की मरणशीलता का अध्ययन तीन वर्ष तक अगेनी बीज की छह लाख फसलों पर संस्थान की रोपावनी में तीन विभिन्न पोषियों पर किया गया। औसत मरणशीलता प्रतिशत पलाश पर 41.20 से 60.20 तक, बेर पर 30.49 से 48.84 तक तथा भलिया पर 29.65 से 52.98 तक पाया गया। मरण के सभावित कारण जलवायु कारक ही नहीं है, टहनियों का ढंग भी है जो स्थापना की उपयुक्तता और रेंगने की अवस्था में अस्तित्व के लिए अधिक स्थान पाने के लिए सघर्ष को प्रभावित करता है और जिनका अन्तिम परिणाम इस दौड़ में निरन्तर पोषण पाते रहने के लिए उपयुक्त जगह न मिल पाने से कीड़े का मर जाना होता है।

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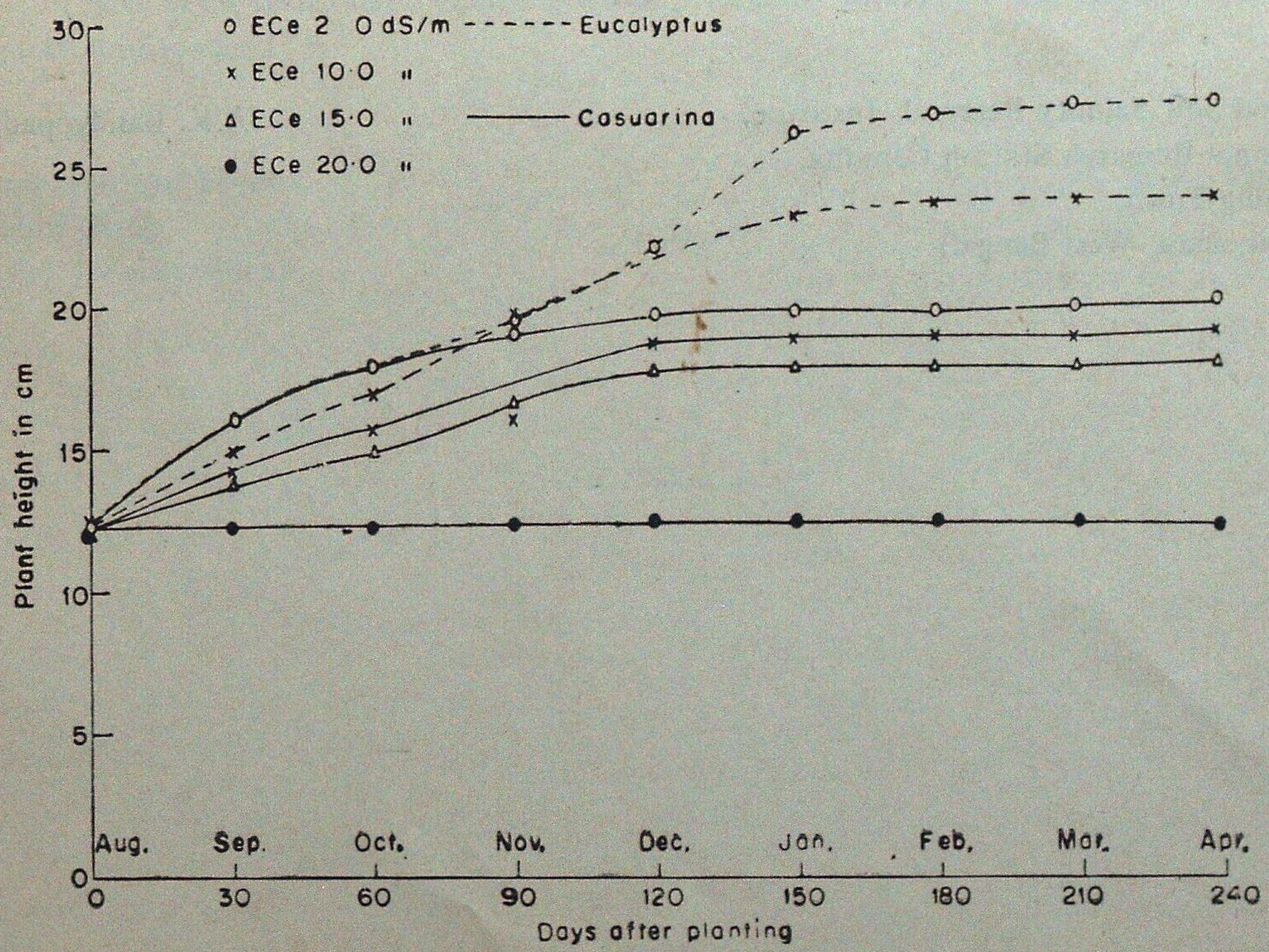
RESEARCH NOTE

A NOTE ON THE EFFECT OF SALINITY ON GROWTH OF *EUCALYPTUS* AND *CASUARINA* SEEDLINGS

Plantation of trees is going on in a large scale in India. In Sundarban area *Eucalyptus*, *Casuarina* and other species are planted. Performance of all these species are not always satisfactory. Accordingly, an attempt was made to study salt tolerance of *Casuarina* as well as *Eucalyptus* seedlings during the initial stage of planting as mortality is high at this stage.

3 months old seedling of *Casuarina* and *Eucalyptus* were transplanted in pots with 20 kg coastal saline soils (52% silt, 37% clay and 11% sand) having ECe 2.0, 10.0, 10.0, 15.0 and 20.0 dS/m in three replication. Two seedlings were transplanted per pot. Salinity of the soil was prepared by addition of diluted Matla river water (EC 18.6 dSm^{-1}, Na^{+} 173.9 m.e q / lit,

Fig. 1



Effect of salinity on initial growth of *Eucalyptus* and *Casuarina*.

Ca^{++} — 11.5 m.e q / lit, Mg^{++} — 95.5 m.e q/lit, Cl^{-1} 207 m.e q/lit) to have desired EC values. Both *Casuarina* and *Eucalyptus* seedlings of equal height were transplanted in August and observations regarding height and mortality were noted upto April next year and important observations are presented in Fig. 1. Distilled water was added to maintain soil moisture and soil salinity. Soil salinity data are recorded throughout the growth period to maintain desired EC values. So far as salinity of the soil is concerned plant growth in both the species were better in saline soil upto 10 dSm^{-1} as can be seen very clearly from the figure. Growth of *Casuarina* was stunted in soil having ECe 20 dS/m. It seemed from the figure that rate of growth (as measured by height) of *Eucalyptus* is higher than that of *Casuarina* in all the salinity ranges. *Eucalyptus* seedlings died at 15 and 20 dS/m ECe. Repeated transplanting could not save the seedling which signified the susceptibility of young *Eucalyptus* seedling above 10 dS/m ECe.

Rate of growth of *Eucalyptus* was higher during winter as compared to *Casuarina* seedling.

The experiment suggested transplanting of *Eucalyptus* seedlings in saline soils having soil salinity less than 10 dSm^{-1} and *Casuarina* seedlings preferably upto 15 dSm^{-1} to avoid mortality of seedlings.

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A.K. Bandyopadhyay

MY EXPERIENCE

(I)

RAINBOW AT NIGHT IN MOONLIGHT

I was returning to Nashik from tour on 6-10-87 from Ahemednagar. On way I passed Sangamner town at 19.05 hrs. The day had been a rainy day and the sky was overcast It looked as if there would be showers any time. From Sangamner, at a distance of about 10 kms, there is Ghat called Karheghat and my car was approaching the lower end of the Ghat at 19.20 hrs or so. On the east, the full moon (Ashwin Poornima) had come up and was at approximately 20° from the horizon. On the west light drizzle had started. And in this setting a full rainbow was visible at 19.21 hrs. Two ends of the rainbow appeared to be coming out of the hills of Karheghat. Rainbow lasted for exactly 4 minutes and vanished when the rain stopped. It was important to note that sun had set that day at 18.30 hrs.

I have never seen such a phenomenon of "rainbow in the full moonlight". This may interest your readers.

Conservator of Forests,
Nashik Circle.
Nashik (Maharashtra)

A.R. Maslekar

(II)

FREAK COUNTERSHIP DISPLAY BY WHITE THROATED GROUND THRUSH

On the morning of 23rd February, 1988, at 07.00 hrs, a ceaseless squeak of a bird, in varying tones, caught the attention of the auther. On following the sound, which was unfamiliar and quite high pitched, a pair of colourful birds with rufous underbelly, white patch on throat and two dark stripes leading to eye from chest, was located, perched some 5 m high on a branch of *Ficus glomerata*. Strange enough one of the birds was sitting in a fixed 'head bowed' posture with both wings drooping, and was continuously giving the call for almost 40 minutes. It did not move a bit, as if transfixed to the perch. The other kept sitting a little away from the calling bird, apparantly disaffected and only once did it flit to another branch and then came back to the original perch.

The bird was white-throated Ground Thrush (*Zoothera citrina cyanotus*) and the male was engaged in a courtship display.

The breeding season for this local migrant is—May to September, chiefly June to August (Monsoon)-yet it was so vigorously and vociferously displaying on a February day. Could it be, that as it had rained heavily on the evening of 21st of February, and there was thunder and lightening though no rain on 22nd of February, it all being part of an unusual weather variation that had continued off and on, since 9th of February, 1988, monsoon conditions got simulated and duped the male into displaying. It may also be added that after that incident despite best of efforts only twice has a solitary white throated Ground Thrush been sighted again, till date, once on 24th of February at 15.00 hrs perched 4 m high on *Peltophorum ferrugenium* branch, preening itself and then again on 3rd of March perched 2.5 m high on the same *Peltophorum* tree at 18.00 hrs, preening itself vigorously. May I further add that sky remained overcast off and on, in Chandrapur, till 2nd of March 1988 and cleared thereafter.

Central Forest Rangers College,
Chandrapur (Maharashtra)

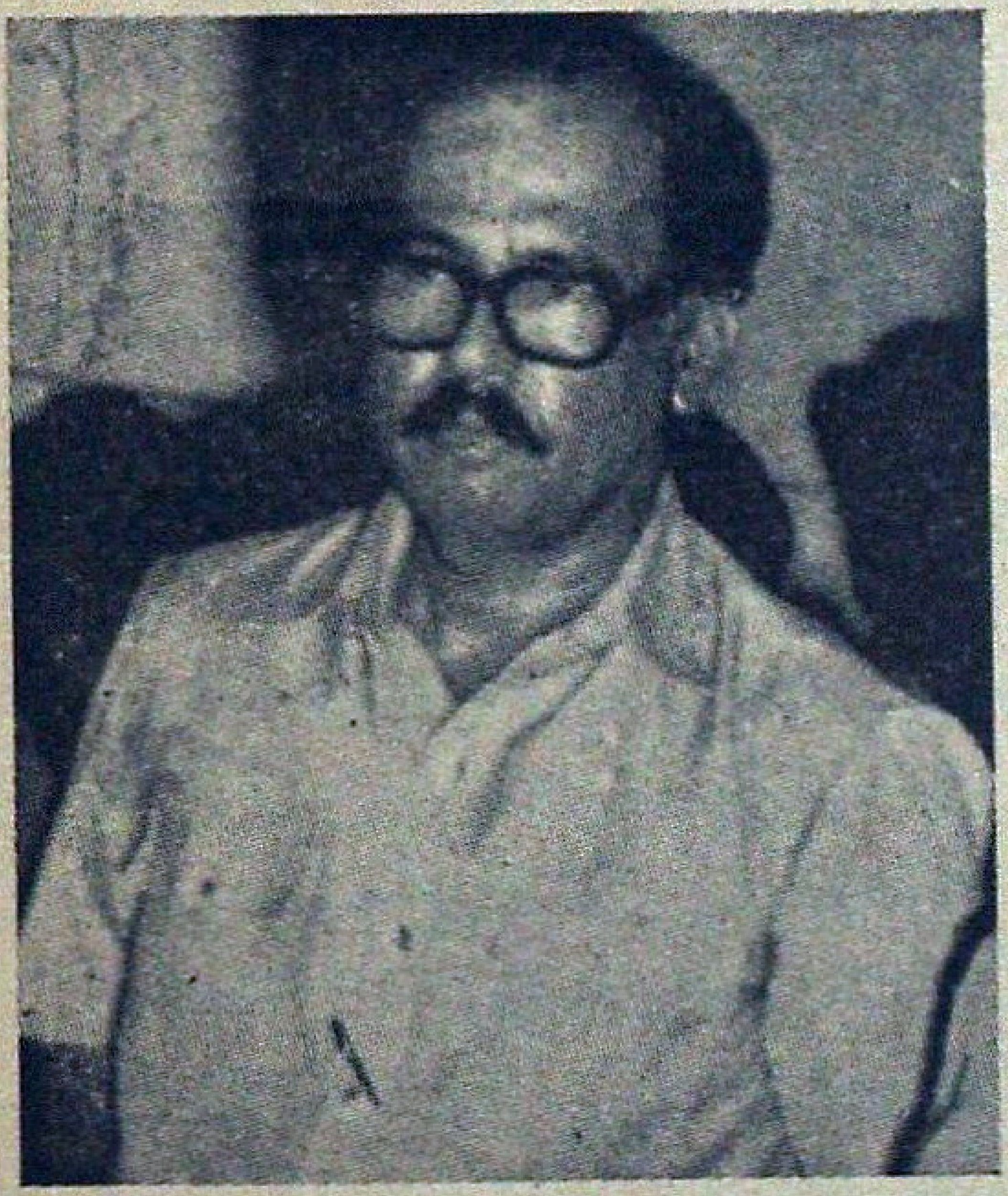
M.K. Misra
Instructor

OBITUARIES

(I)

Jeyapal Wilson

(21-2-1932—25-4-1988)



Jeyapal Wilson lost his life in a car accident on the Vellore-Madras road on 25th April. Death was almost instantaneous as a result of a head-on collision with a public transport bus. His eldest son at the wheel, a medical graduate, suffered multiple injuries and is under treatment at the Christian Mission Hospital, Vellore.

Death has stolen yet another march over life in a tragic fashion. It is specially poignant to be fated to watch a career from its baptism, thro' sunshine and rain to its sudden end. One dim morning well before dawn in 1952, Wilson and three others, new recruits to the then composite Madras Forest Service (due also to rise to the top of the echelons in their States) started off on their 20 mile walking test from the Coimbatore Race Course quarters of the writer, then District Forest Officer, South Coimbatore, whose privilege it then was to conduct the test. The first of many walks for this tireless walker, over hill and dale, a planter in his own right and one known for the throughness of his field inspections and for his intimate knowledge of the terrain. A legacy of hard work and commitment, he leaves behind. Never at a loss for ideas, innovations and initiatives, he fully enjoyed the scope for creativity which the foresters job confers on those that seek it. It was always a pleasure to sit and exchange thoughts and get abreast of experimental work of common interest.

Wilson held the post of Chairman-cum-Managing Director of the Government Rubber Corporation, Nagercoil of the rank of Chief Conservator of Forests from 7th August, 1986.

To the bereaved family, Mrs. Wilson, their three sons and a daughter go our profound sympathies.

May his soul rest in peace.

A.M.M.H.

(II)

B. Marappa
(6-4-1917—15-8-1987)

Shri B. Marappa, IFS (Retd.), died at Bangalore. He was 70. Educated in the famous Central College at Bangalore, obtained his B.Sc. (Hons) degree in Botany and passed out of Indian Forest College, Dehra Dun with an A.I.F.C. Diploma in 1947. He was the first state Silviculturist in the erstwhile Mysore State which was attached to the Forest Research Laboratory at Bangalore under the State Government. He worked in various capacities as Forest Utilisation Officer, Bangalore and DFO of Shimoga, Tumkur, Bangalore and Kolar districts.

He was promoted as Conservator of Forests in 1970 and worked in Belgaum and Kodagu Circles and as Director, Wild Life Preservation, Bangalore. He retired in April, 1975.

He was a true field officer. The successful Tamarind Plantations of Kolar, Bangalore and Tumkur districts, the afforestation programmes around Nandi hills (Kolar) and Devarayanadurga (Tumkur) at present bear the testimony of his hard field work. He had the privilege of participating in all Khedda operations from 1948 to 1971. He was jovial with his colleagues and kind towards his subordinates. He was a water diviner himself and good photographer. His untimely demise is a great loss to forestry science. He leaves behind his wife, a son, three daughters, other relatives and friends to mourn his death.

May his soul rest in peace.

N.S.

LETTER TO THE EDITOR

To,

The Hony. Editor,
Indian Forester,
P.O. New Forest, Dehra Dun.

Subject : **Monkeys in New Forest : A Point to Ponder**

New Forest Estate, with its 4.45 km^2 area with various types of forest plantations, shrubberies, fruit trees, kitchen gardens and perennial water supply provides an ideal abode for monkeys (*Macaca mulatta*). The monkeys largely feed on fruits, berries, leaves, flowers, seeds, buds and barks. Apart from it grasshoppers, beetles, ants and termites are also eaten. Honey combs are also some times snatched and eaten.

There are 3 groups of monkeys in the New Forest Estate and total number is 95. The largest group of about 45 monkeys is generally seen near Teak Gate and infests the area from Champion Block to Takley Road. Second group of about 30 from Kaulagarh Gate to Bungalow No. 9 and third group of 20 invades from Golf Course to Traver Road, North of Canal and sisters' quarters. Some solitary males have started reaching upto B type quarters also. They cause considerable loss to the plantations and cultivated crops by damaging the plants or eating and spoiling the various edible parts. Monkeys are so clever that they eat the inner ripening portion and throw away the raw and hard outer portion of fruits. Breaking of tender branches and leading shoots by them are very common. In the experimental plots of Model Teak Seed Orchard and *Leucaena leucocephala*, planted by me, strict watch had to be kept from early morning till late evening to save the plants and the pods from their approach. Young monkeys often play a game, follow the leader. The leader climbs up a grafted plant and comes down from a side branch and rest of the group members follow him. Some times all of them reach to the branch together and on account of their weight and jerky movements the branch breaks. After sometime a new branch is selected and game continues.

I have pondered the problem and have discussed it with several people but so far nobody has been able to suggest appropriate measure to curb their activities. Sooner or later when their natural food would become scarce the Monkeys in New Forest may get desperate enough to enter houses in search of food and conflicts with human beings. Can any reader suggest, tried and trusted practical measures to undo the menace.

Yours faithfully,

Sd./- M.S. Rawat
Officer-in-Charge,
Indo-Danish Project Centre,
Forest Research Institute, Dehra Dun.

GAZETTE NOTIFICATIONS

ANDHRA PRADESH GAZETTE

The following appointments and postings are ordered :

Shri K. Kesava Reddy, IFS, Conservator of Forests who is now on O.D. in Telugu Ganga Project is promoted and posted as Additional Chief Conservator of Forests, D.P.A.P., Hyderabad relieving Shri N. Jyaram, IFS, Addl. Chief Conservator of Forests (E) of Additional Charge of the post of Additional Chief Conservator of Forests (D.P.A.P.).

Shri T.V. Rangarajan, IFS, Conservator of Forests is promoted and posted as Additional Chief Conservator of Forests, Wild Life and Accounts, Hyderabad.

KARNATAKA GAZETTE

The following officers borne on the Karnataka Cadre of Indian Forest Service are promoted to officiate in the Junior Administrative Grade of Indian Forest Service with effect from 1-4-1988 :

Shri G.V. Sugur
Shri G.S. Prabhu
Shri Vinay Luthra
Shri P. Srinivas
Shri Kanwarpal
Shri Chellaswamy Raju
Shri M.H. Swaminath.

WEST BENGAL GAZETTE

The Governor is pleased to appoint, until further orders :

Shri P. Sukla, IFS, Divisional Forest Officer, Wild Life Division-II as Divisional Forest Officer, Baikunthapur Division with effect from the date of his assuming charge.

Shri P. Vyas, IFS, on return from training in Wildlife at Dehra Dun as Divisional Forest Officer, Wild Life Division-II with effect from the date of his assuming charge vice Shri P. Sukla, IFS, transferred.

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3. The Assistant Conservator of Forests,
(Depot Division)
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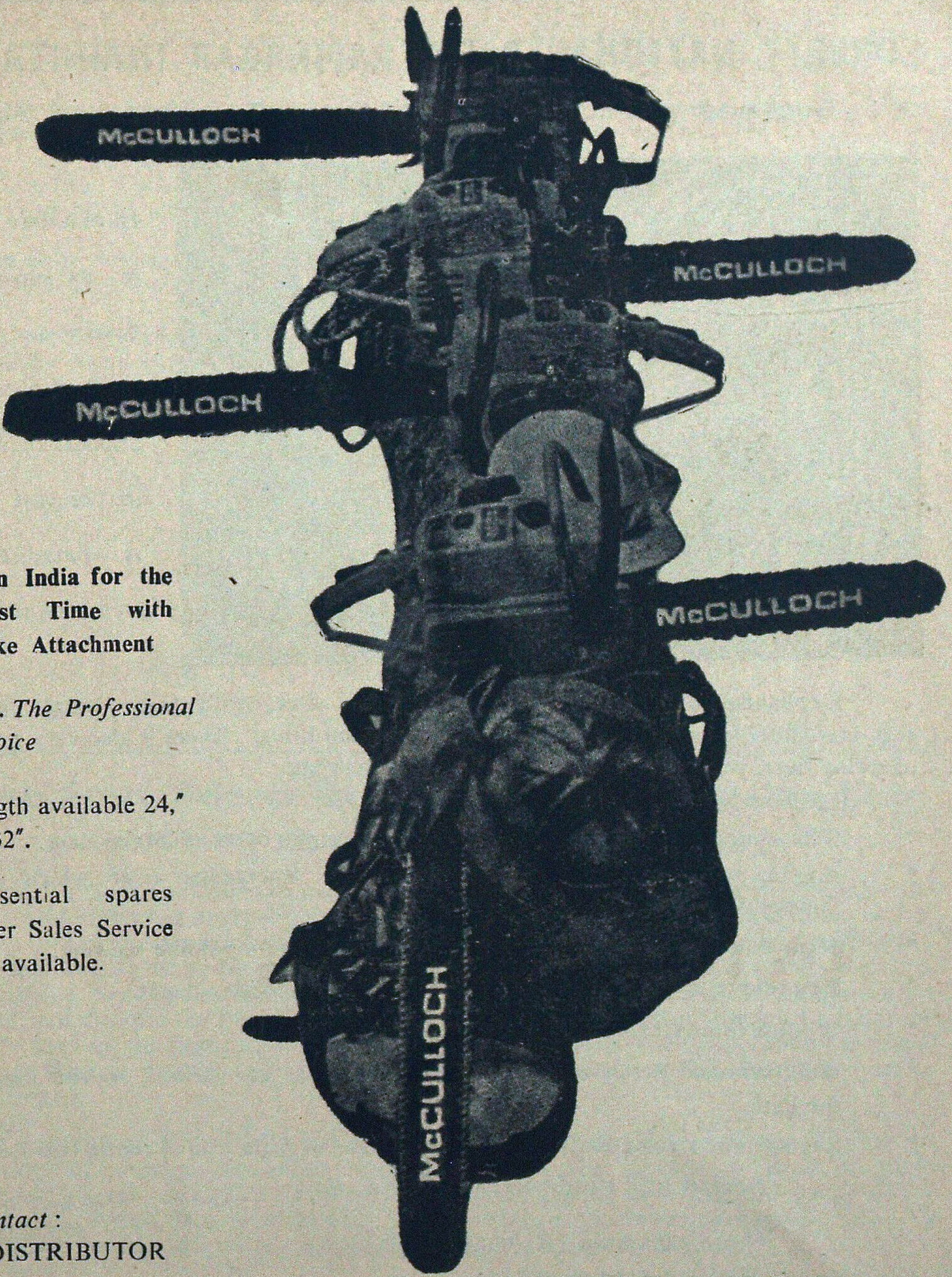
Marshalling Yard, Port Trust, MADRAS.



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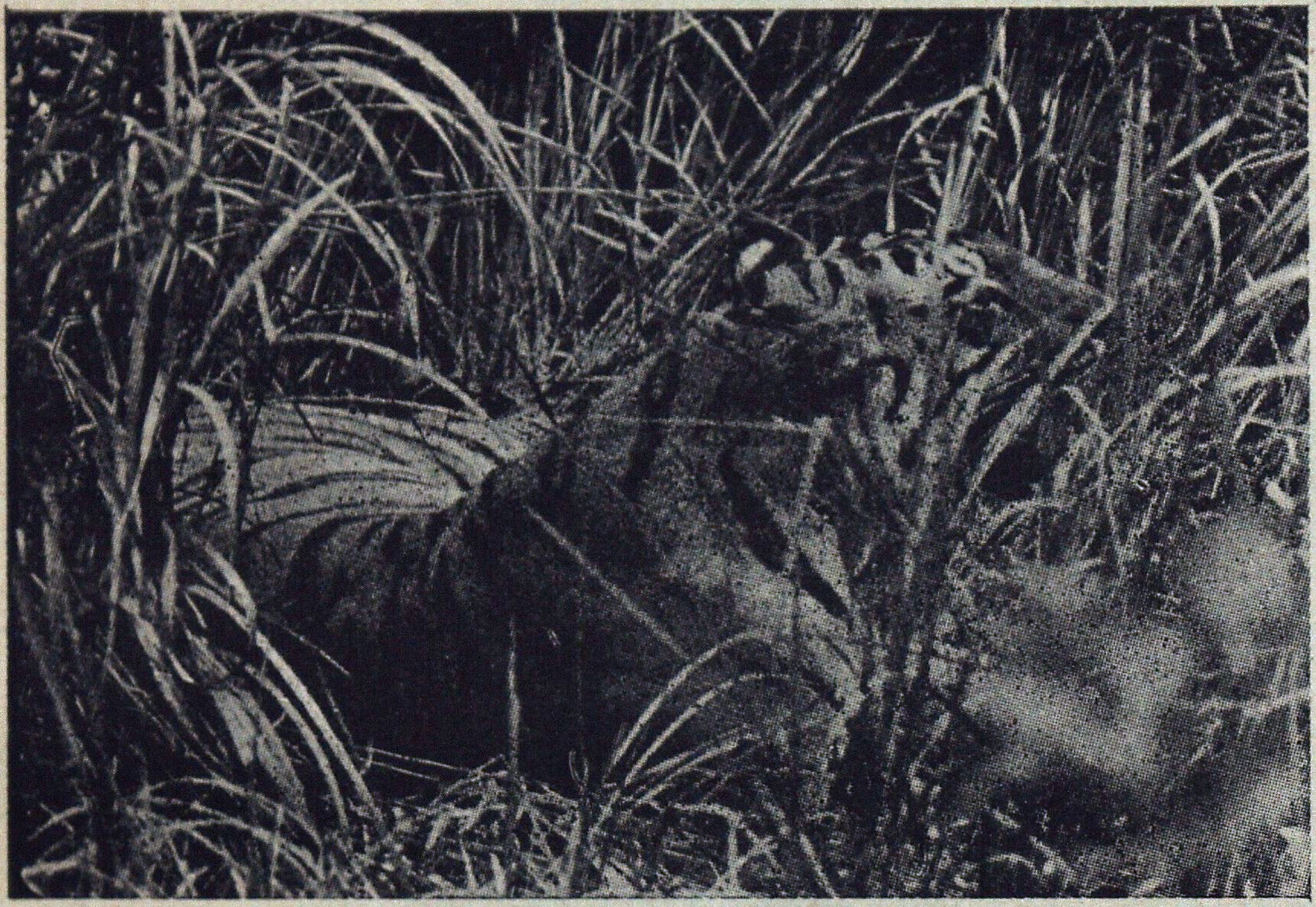

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76—Residence

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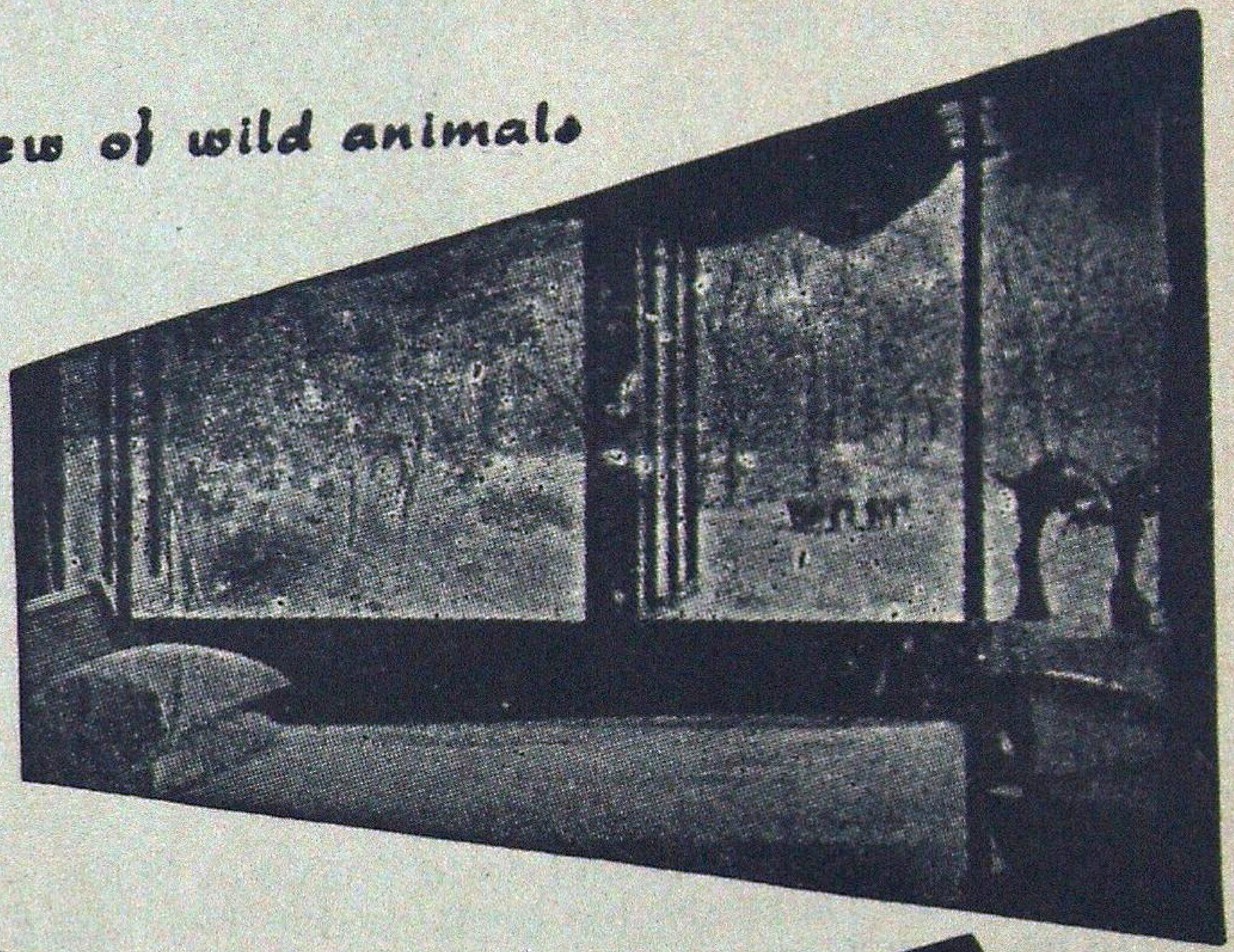

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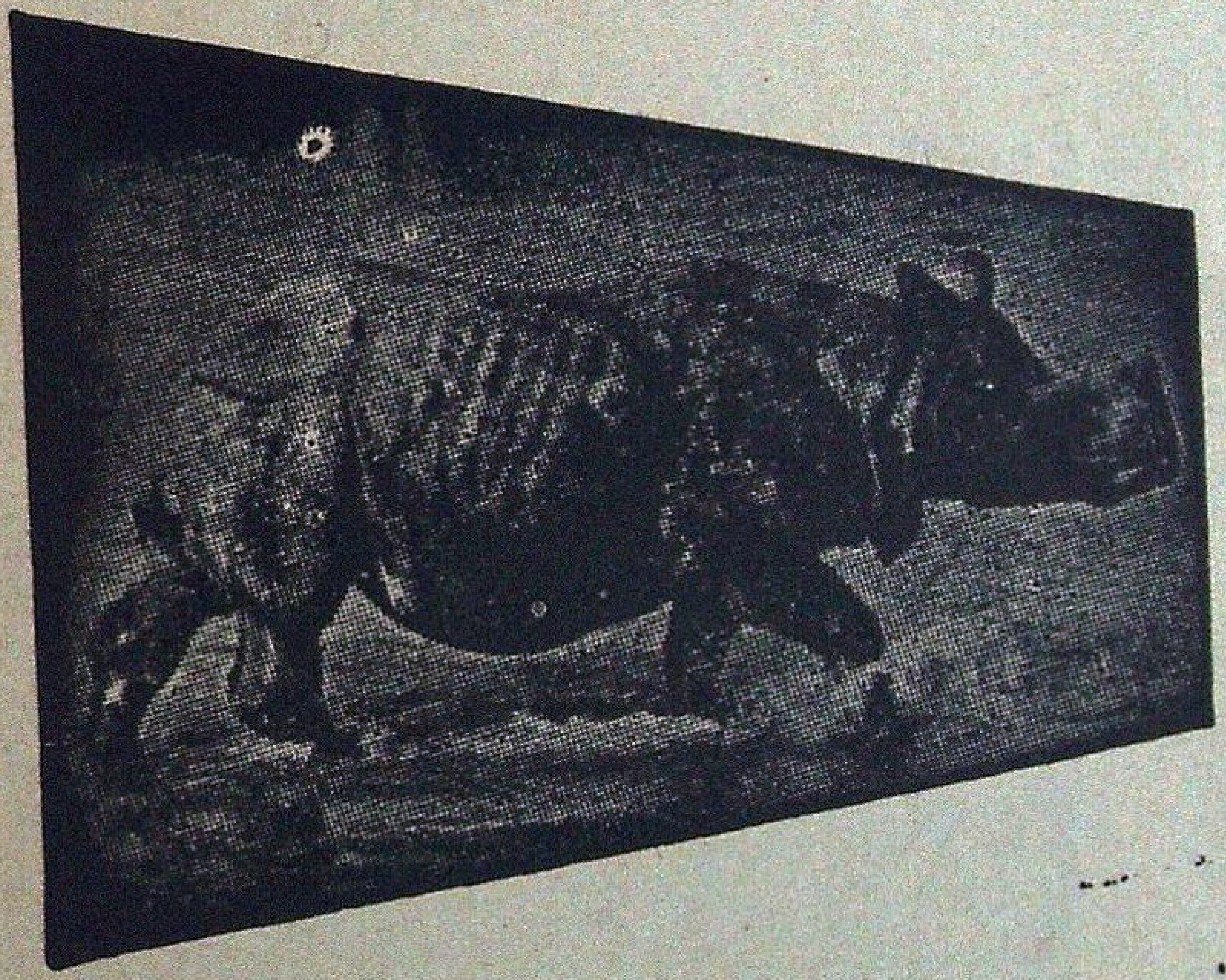

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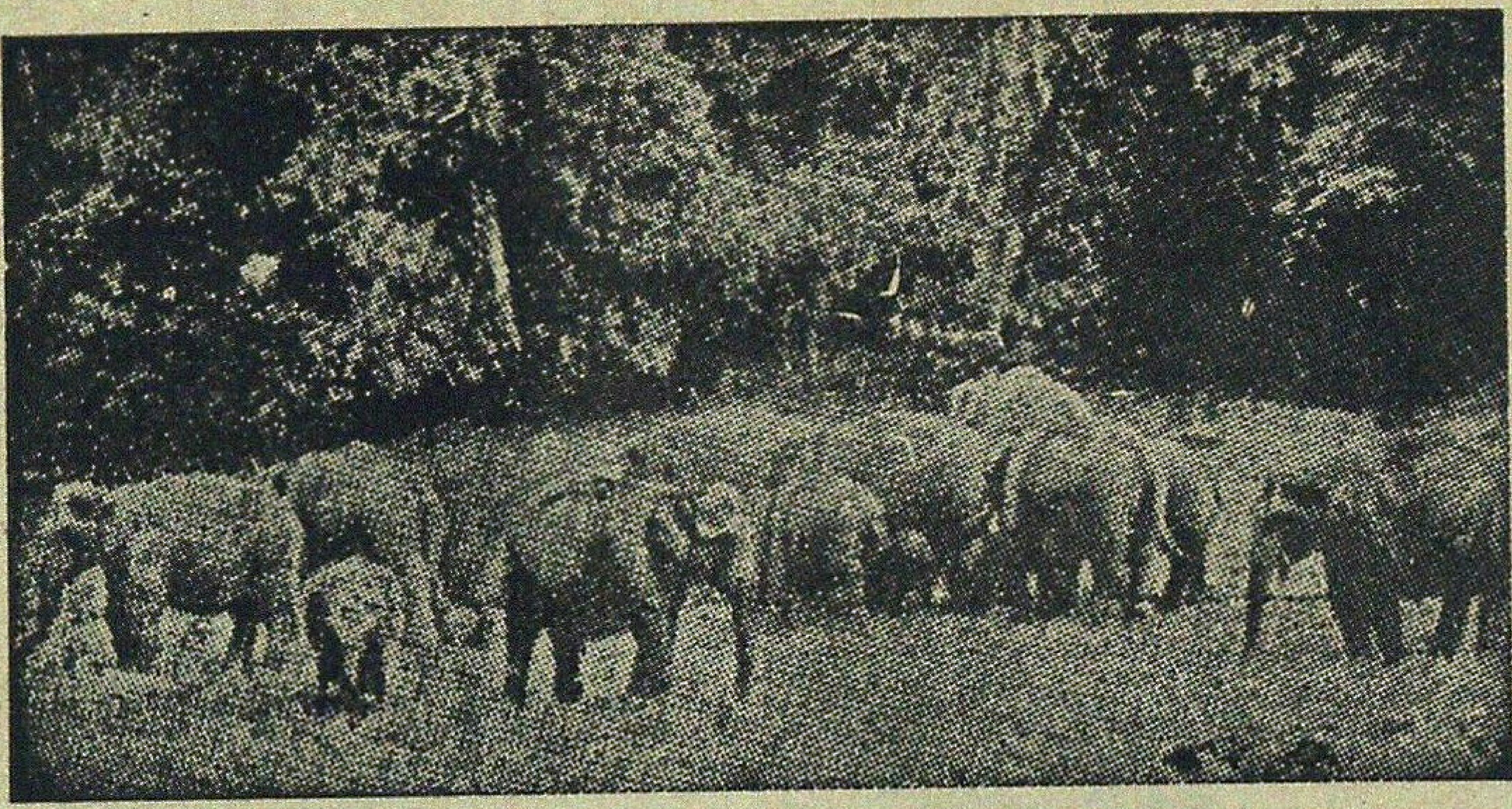

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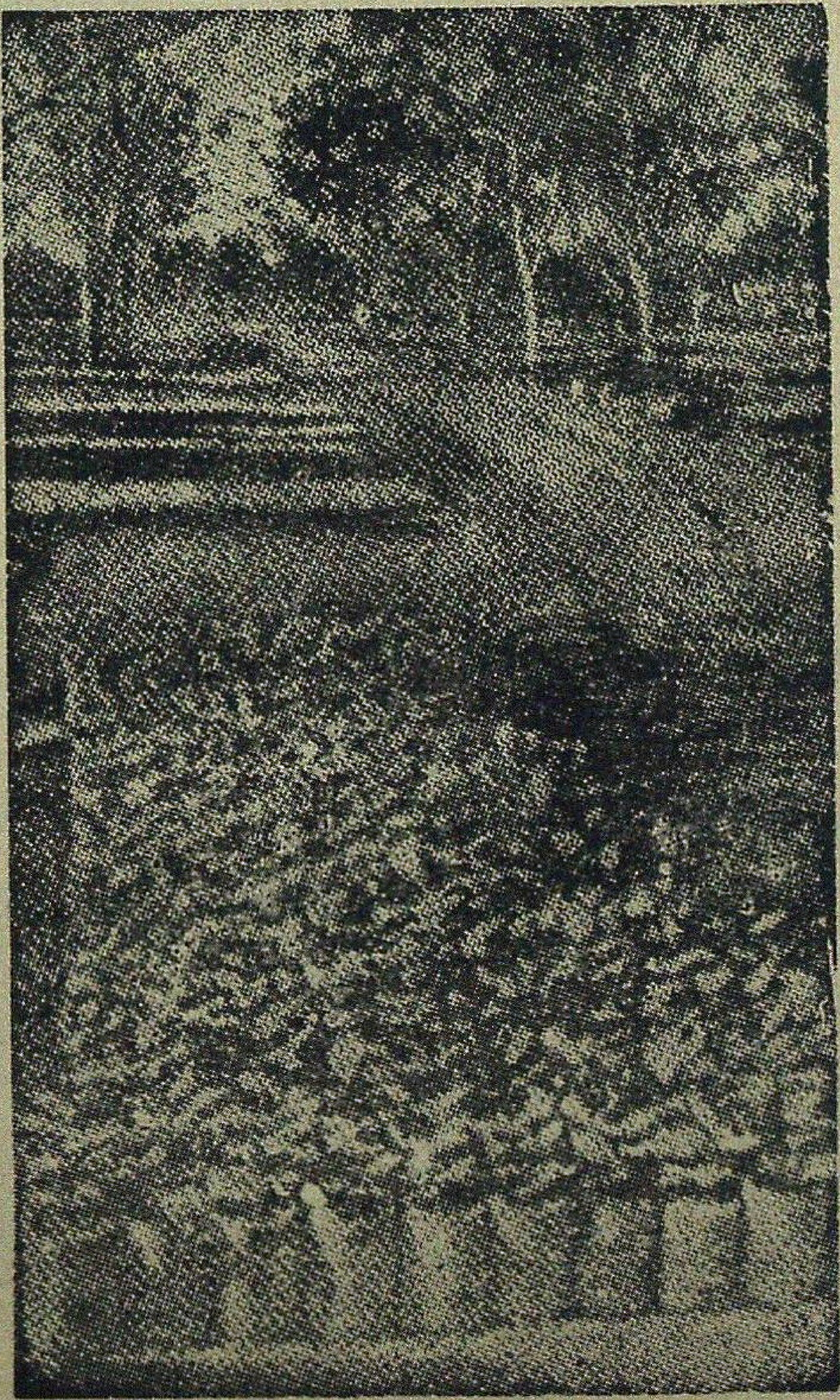

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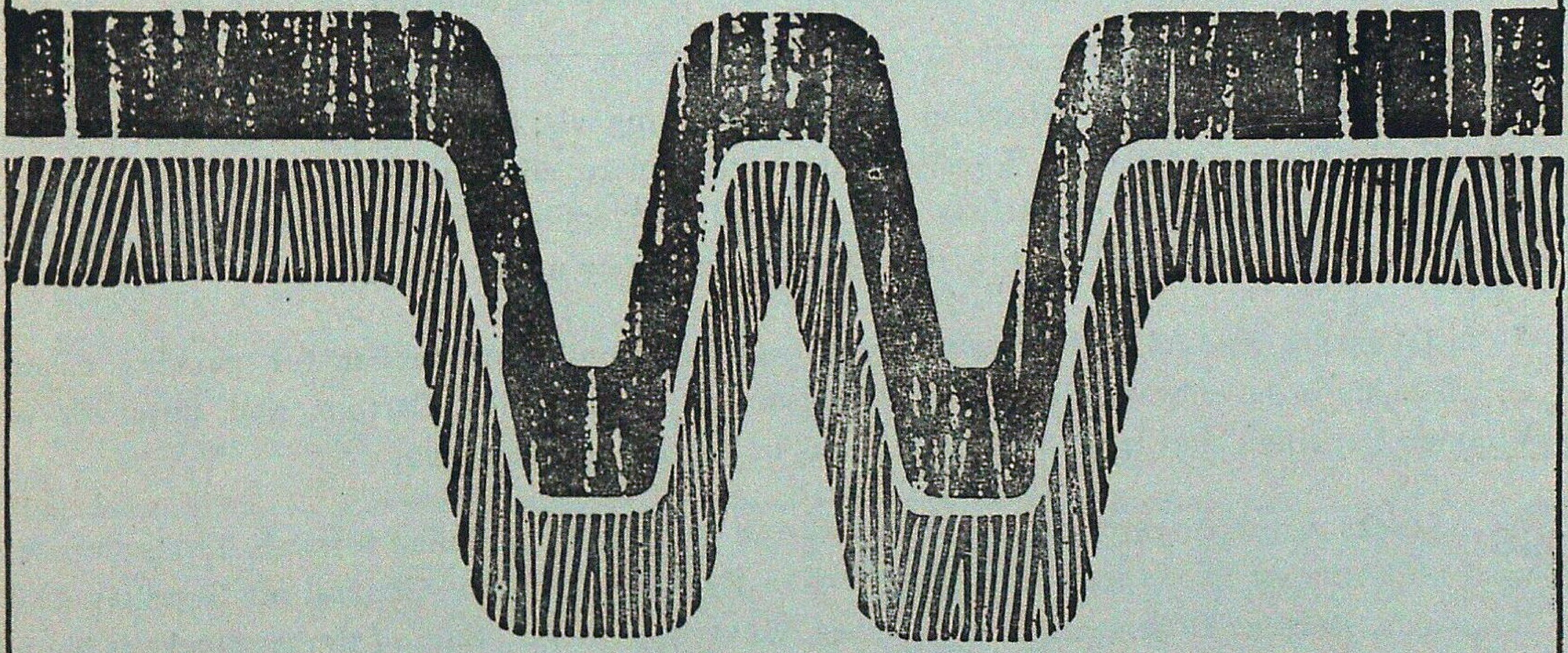

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When the Mizo District Council came into being in 1952, the management of all the Forest other than the State Inner Line Reserved Forests was handled by the District Council. Thence the District Council started to make its own Forest Wing. Under the District Council one Forest Division called Aizawl Forest Division was created comprising the then whole area with headquarters at Aizawl. In fact during the time of the then District Council, most accessible areas of the forests had been overtapped for earning more revenue and due to population pressures.

In the early 1960's the first plantations were raised by the District Council in different centres. During the year 1966 – 1968, practically no plantation could be raised due to political disturbance in the Mizo District.

After Mizoram became a Union Territory in the year 1972, the Union Territory Government formed one more Forest Division with headquarters at Lunglei.

The present position of Mizoram Forest Department may be summed up as follows :

The Mizoram Forest Department is headed by the Chief Conservator of Forests. The field work has been taken up with ten (10) Territorial Divisions. In addition to this, six (6) Functional Divisions have been set up. There are now three (3) Circles namely—Southern Circle, Northern Circle and Research & Development Circle. The Government of Mizoram has already constituted three Wildlife Sanctuaries in order to preserve its vanishing Wildlife. Four more Wildlife Sanctuaries are being proposed which are likely to be constituted very soon. The Mizoram Forest Department has created 1,00,029 hectares of plantation upto 1987 as against 967 hactares before it attained U.T. Status.

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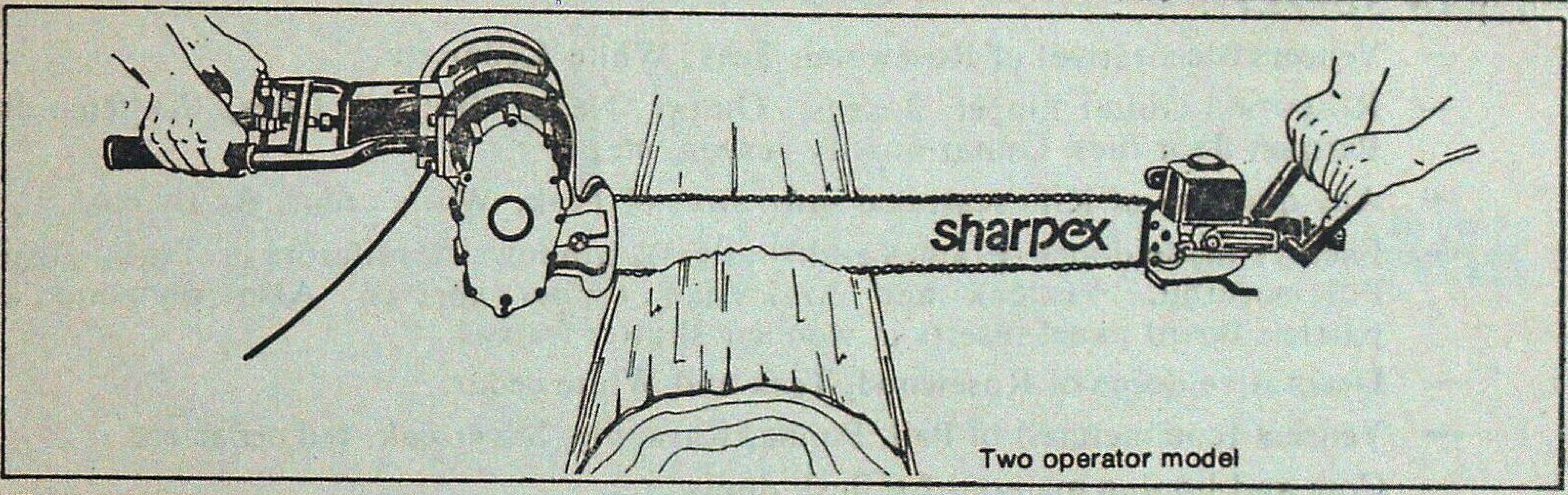

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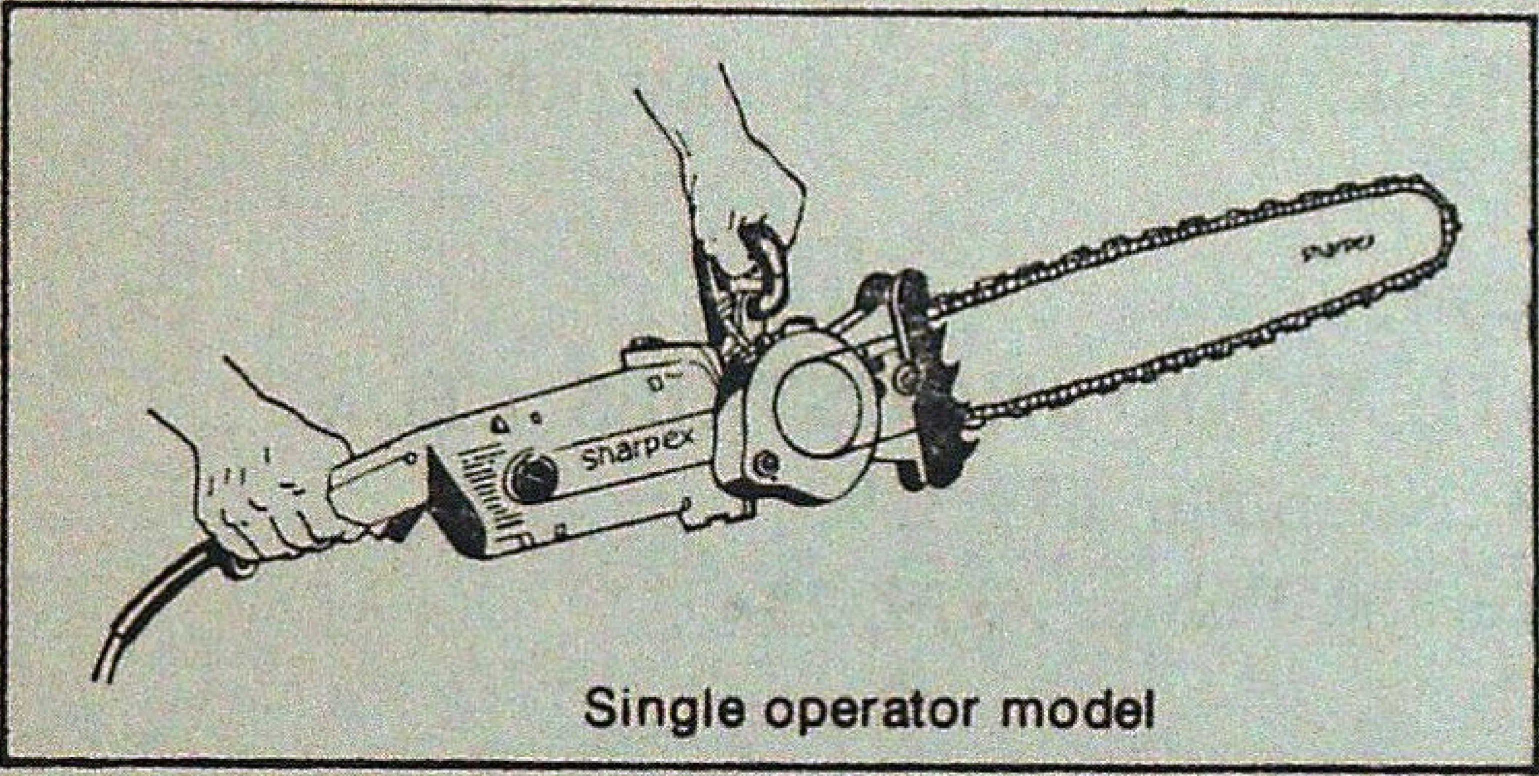

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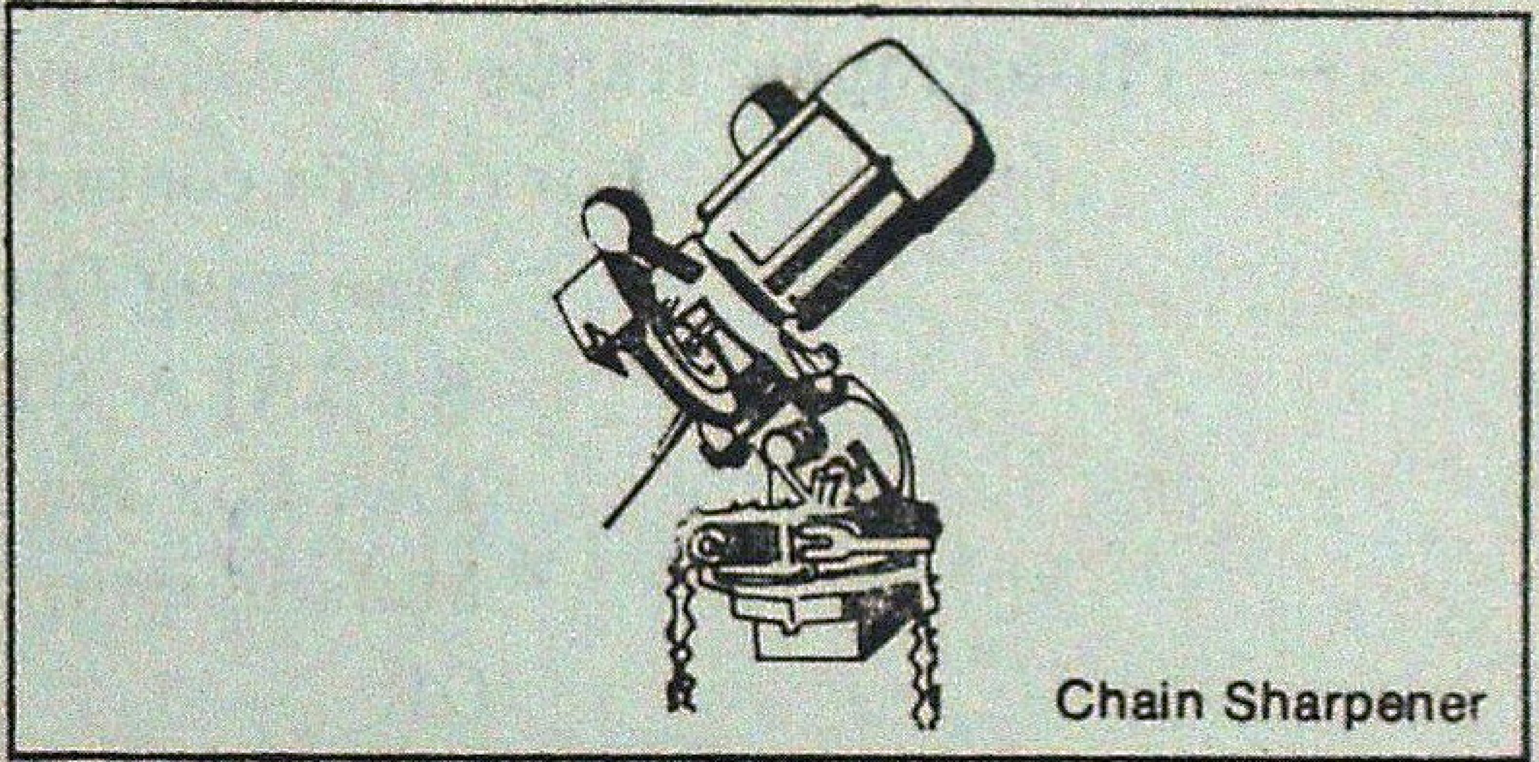
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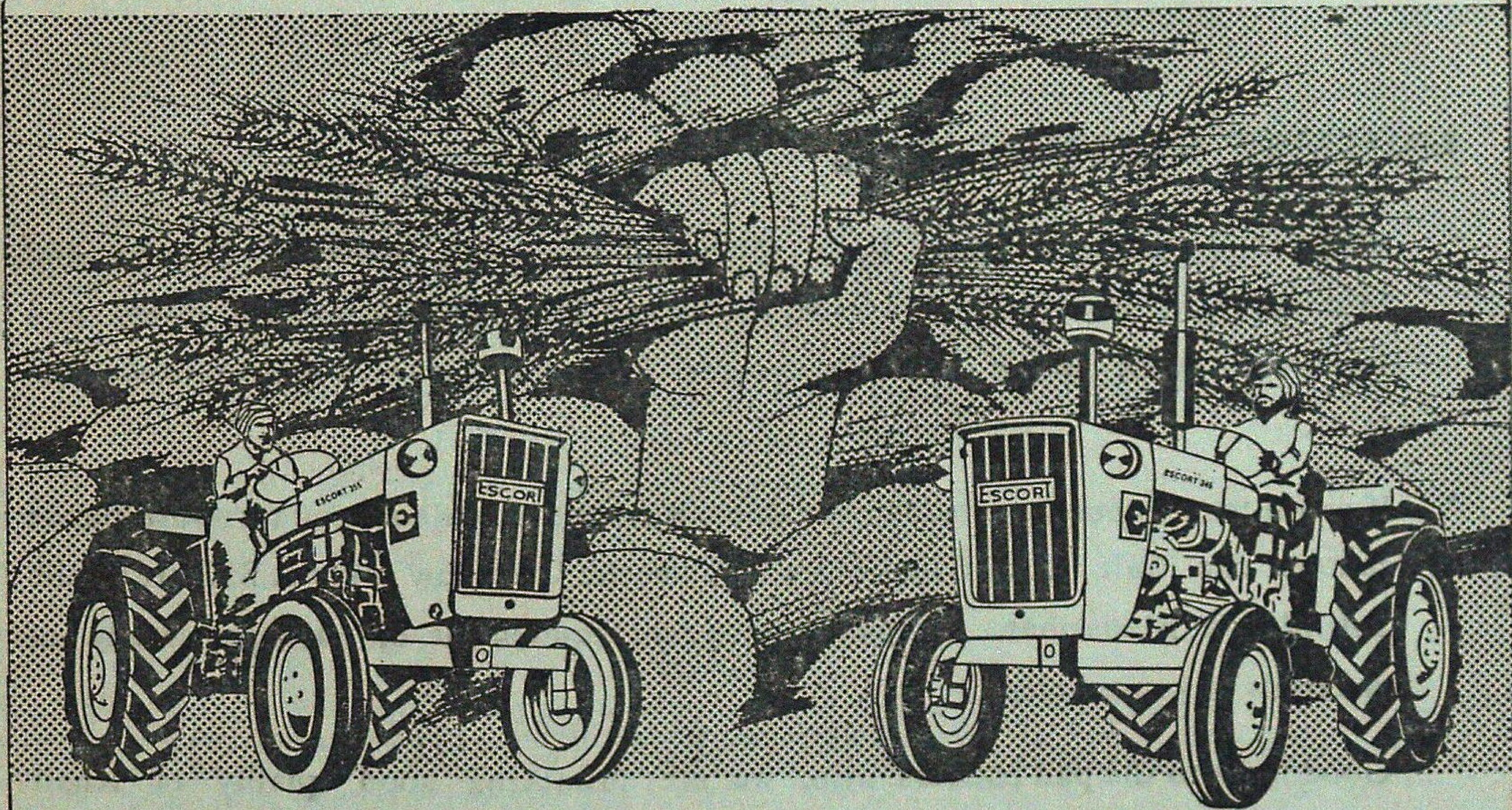

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RECLAMATION OF DEGRADED HILL SLOPES THROUGH SHRUB, JOSHIMATH.
Photo—S. Nautiyal ... Front Cover

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